

3 June  
with 1930  
A. A. Stoyanov

Music Mountain west of Peach  
Springs, Arizona.

The lower portion of the slope  
north of the road is granite.

Lying on the granite is  
about 10 feet of quartzitic  
Tapeats sandstones, cross-bedded, usually  
purple or purple streaked, in  
other words the usual  
Cambrian basal quartzite.

This grades up into a thin  
Bright Angel series of typical Bright Angel  
shale. Micaceous, brightly  
colored with perhaps a lot more  
sandstone layers and perhaps  
also lime.

This shale grades upward into  
Muav limestone, which here attains  
a thickness of 800-1000'. Compared  
with the Grand Canyon the main  
difference noted, in general, was  
the true mottling rather than  
subly structure. The mottles  
are yellow sandy patches,  
either in the form of Spiranellas  
blotches or worm tubes. Some of  
this bed resembles the wormy  
Eldon of B. C., except that the "tubes"  
(irregular) are yellow and not



## Music Mt, (cont)

white.

Much Girvanella occurs here. It is a little larger than is usual for the M.C. type, but otherwise quite similar.

Trilobite fragments (unidentifiable) occur in the lower Muar as well as in the sandy layers of the underlying Bright Angel.

Devonian follows.

[Dr. Stoyanov has measured section]



St. Gene  
with  
AA Stogamond

East of Del Rio, Arizona.

On the edge of the plateau at this place, the granite is exposed, overlain by a sandstone like the Tapeats Shale which is succeeded by Devonian limestone.

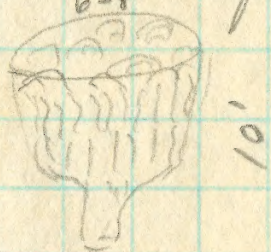
A little to the north of this first locality a thick series of metamorphosed quartzites intervenes between the granite and the Devonian sandstone.



Algae in Chuar series.  
Naukoreap.

Lowest Simply crinkly bedding. Up to several  
Exposed feet in thickness.

Occurs above white, strongly crossbedded,  
base former coarse ~~sd~~ sandstone. Forms layer  
perhaps 10' thick over whose rounded masses  
the overlying shale is laid in sharp folds.  
In the lower part of the formation the  
individual colonies are small rather  
irregular cylinders which sometimes bend  
rather sharply. These cylinders show  
the regular Cryptozoon structure  
and widen a little as they grow.  
Taken together they form large masses  
that are described below. In the upper  
part of the bed the small cylinders  
give way to large rounded heads.  
Both the cylinders and large heads  
combine to form huge vase-shaped  
masses. Usually the base is narrower  
than a regular flare would require.



Walcott makes a good drawing in  
his note book. Sample of the small  
tubes taken.



Alga (Chiron) com.

upper zones. Irregular broken, usually blackened algae. Some appear to have been turned over by the waves.

Above this zone there is an oolite layer that is usually altered to black chert. The oolite

Topmost limestone has very little algae. All are indefinite and broken.



19 June

1930

with E. D. McKee

Kaihab Trail.

Above Power house.

Tapeats typical in character and  
thickness



24 May  
with 1930.  
G.A. Stoyanov

Nankowap Creek,  
Lower Portion. [Box canyon  
above Colorado R.]

Beds tilted toward river at about the same angle as the stream grade, in consequence the creek flows in the Muar almost all the way.

Just above the box canyon on the west side the Muar is faulted against the Tapeats - at x in a thin



sandy layer I got fossils - Dorypyge. Dr. Stoyanov and I agreed, after considerable search that these are actually in the Muar, which therefor proves conclusively that this formation is Middle Cambrian as we had previously deduced on theoretic grounds.



Recent Algal deposits in  
Mankowcap Canyon.

Gravel and sand along stream  
either above or below the water level  
is cemented.

#

Below camp in side canyon a seep is depositing  
much lime.

#

At camp springs are depositing lime  
white spongy type with leaves and stems  
enclosed.

#

Elsewhere where water first issues  
tufa usually occurs.



Arizona

Grand Canyon

Walcott 1879



~~P. 8375~~  
8375

Chas. Walcott  
U. S. Geological Survey.

0.591  
0.364  
0.039

8375

Notice strata at <sup>52</sup>attenuated of  
Carboniferous, also character  
of bedding throughout.

*[Faint, mostly illegible handwritten notes and sketches, possibly including a diagram of a fold or strata.]*



Aug 12<sup>nd</sup> 79.

1

ascended hill directly west of Kanab at 200 feet (aneroid) above the level of the stream found small shells in <sup>marly</sup> red sandstone and 25 feet above ichthyic remains, both localities evidently of two species, spent the afternoon searching for them.

Aug 13,

Hills 5 miles S of Kanab.

(1) Brown soft shale, crumbly gypsiferous resting on laminar colored 90 feet shales

3. Massive layers, sep by fine shale, + an asphaltum bearing into thin shales, <sup>chocolate</sup> brown 50 feet

3. Massive

Reddish brown shale 30 feet.



light colored sandstone  
probably conglomerate in place  
with siliceous wood 50 feet  
this is overlain by a layer  
of sandstone similar to the  
rest of sandstone  
Thickness - 20 feet to summit of  
hill (Section Continued at p 6)

From the summit to the apex  
of conglomerate, capped with  
brown sandstone, running  
out from the east side of  
the Hoab valley 4 miles  
below the top of the cliffs  
of the Vermilion Cliffs.  
near the above the cliffs  
to the east & went off  
the canyon.

The Shinarump Canyon runs  
slightly towards the east &  
is entirely (nearly) continuous  
on the hills a mile or so  
back from the valley  
to the west it passes  
under the lower

sandstone. (3) The Congl.  
consists largely of a coarse  
brown, unconsolidated  
small quartz pebbles scattered  
throughout it irregularly,  
with an occasional thin  
fragment, for instance 1 ft in  
thickness. The pebbles are  
of various sizes and are  
and broken before being imbedded  
in the sand. Some fragments  
are rolled round (where  
others are chert like  
& some are chert like)  
Some are more than 6 x 5 ft  
upon which there was a  
pile of siliceous wood  
in the sand - long bones & other  
fragments 15 in diameter & 2 ft  
long & other small broken  
all water worn & rolled.

Dip of Conglomerate beds N. 175°  
" of Vermilion Cliffs " "





Section across Conglomerate  
 Line of fault 250 w of N.  
 Section.

The Conglomerate<sup>(5)</sup> gradually rises forward the west until a break is met with on the east side of the valley this results from denudation. The strata are nearly horizontal at (a) + b and slightly toward the west at (c). At (c) there is an abrupt break + down to the W of 125 feet below (b). The line of the fault could not be accurately determined but it is not far from 250 W of N.





Con of section (b) from page (2)

For a distance of two miles directly north across the valley the strata are buried beneath sand & decomposed rock (shaly sandstone & gypsiferous marls).

Began measurements with locks level at first appearance of banded marls (decomposed, in long low foothill running south from 3rd Cliff (Headland)

w of Kanab canon. To the base of the cliff the strata are composed of slate, dark purplish brown greenish & bluish gray colored gypsiferous marls which have decomposed

& formed low rounded foothills near the cliffs or else stretch out as a level plain to the conglomerate. The marls are variegated in color and contain both nodules & layers of nearly pure gypsum.

Thickness of measured section 350 feet.

The base I have taken for the Vermilion Cliff. This is a band of sandstone. The lower part is

(7)

5850  
5375  
25

light colored ~~sandstone~~ (silt) overlaid by the reddish brown sandstone. The layers are from 2 to 7 feet in thickness, total thickness of stratum.

B-5975

20 feet

Succeeding this there is a mixed mass of marls, sand shales and layers of soft reddish brown sandstone (total) 70 feet. This is succeeded by a mass of R.R. Rd, which is soft & easily disintegrated, numerous thin partings of shale & mud break it into layers of from 1 to 6 feet in thickness. (Total 120 feet)

Total to base of fish beds  
(over) 120  
Lock's line 210  
Amenance 200+  
An 5975

The upper portion of these red beds are more compact & thicker. The lower 150 feet of the above 210 are nothing but passage beds to the Vermilion Cliff from the Shinarump Gk.



At this point there are 3 light sandy layers with shale (4 feet) parting & then 6 feet of fine argillaceous & sandy shale. They vary in color from lead through brown to red with fillets of greenish color, as yet this formation has produced but a few fish scales.

This bed is repeated here a somewhat similar one above by a narrow band of fine light colored sandstone varying in thickness from 2 to 4 feet in thickness. The entire band varying from 20 to 25 feet in thickness. This band is strongly defined on all the prominent headland jutting out from the main cliff & appearing resembling a stuffed ribbon on the face of the red sandstone wall. As the massive strata above & below frequently

present a bold escarpment. It is also of unusual interest as to the present time. It has afforded more fossils than any other stratum & also the first above the Shinarump conglomerate. (25 feet. Massive light colored brown layers, 50 feet)

The cliff is again divided by bands of argillaceous shale and thin beds of sandstone. This bed varies in thickness at this point crossed by the section it is (fish bed) 25 feet. This is succeeded by bedded sandstones varying in shades of red & light colored sandstone extending by one red color washing from above. The layers are irregular in thickness & contain thin partings of soft rock with fragments of wood.

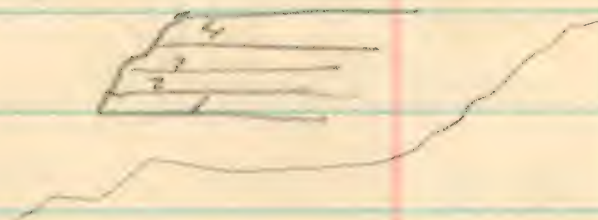
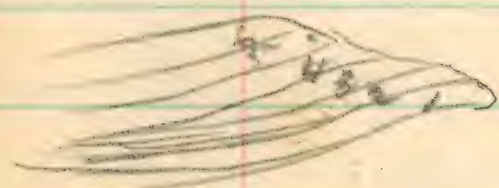


etc. *Schistura bonini*'s also penetrate the beds in many places. When especially abundant the rock is of a yellowish cast. Thin beds of conglomerate occur but not of importance. To the summit of the first white capped cliff above the second fish bone bed.

230+

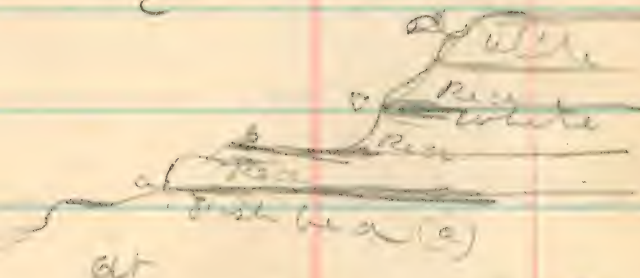
This level is the one on which the signal tower and headland East of Kanab is built. It marks a readily recognized horizon & divides the lower part of the group from the more undulating beds above.

Section of beds above conglomerate 5' W of Kanab. Did not make section here as there had been only as great as the at the section taken 2 of Kanab. 9 mi. A.S.W of Kanab a fault breaks the line of cliffs. The western cliff terminates in a somewhat bold escarpment. The interval between the cliffs to the hills is cut out in a shallow valley rising rapidly to the north.



W

E



The bluff on the east side rises a very little towards the edge. The fish bone bed is readily seen on each about 1 1/2 miles distant. On the west side it has a dip of about 5° to the S.W.



(12)  
Aug 23 d) Continuation of section  
from Page 10.

The light gray <sup>2d</sup> cap of the  
~~horizon~~ a ledge of redish sand  
about 20 feet thick. It is a persist-  
ent feature in all the cliffs  
about Kanab & may be seen  
up the valley for two miles  
where it disappears owing  
to the dip & the rise in the  
bed of the valley.

The  
section is taken up, two miles  
above Kanab, just above  
the point of the fall.

The strike of the strata appear  
to be a little S of west (20°)

The dip 1.75° N.

Above this rest 180 feet of dark  
red sandstone with thick layers  
alternating with shales &  
readily decomposing. Ripple  
marks indicate a shallow  
water deposit formation.

The light colored sandstone  
commences to predominate

(13)  
above this, & forming the same  
rule as at the base of the Gp.  
where the character of the  
succeeding division commences  
to predominate the line of  
separation between the Vermil-  
ion & white cliff divisions  
of the — ? Grouse is  
placed here. 20 feet of evenly  
bedded sandstone (light colored)  
followed by a massive layer  
of light gray sandstone  
which is slightly cross-  
bedded. This is a strong &  
well indicated horizon all  
along the cliffs at Kanab  
& up the canon for 16 miles.

White cliff Gp.

Evenly bedded light colored  
redish sandstone 20 feet

Massive strata partially  
cross bedded — 20 feet  
Massive cross-bedded, light gray  
with occasional redish beds



(14)  
irregularly intercalated 300 feet.  
The upper portion of this mass  
consists of a light colored ~~fine~~  
sandstone (coarsely disintegrated)

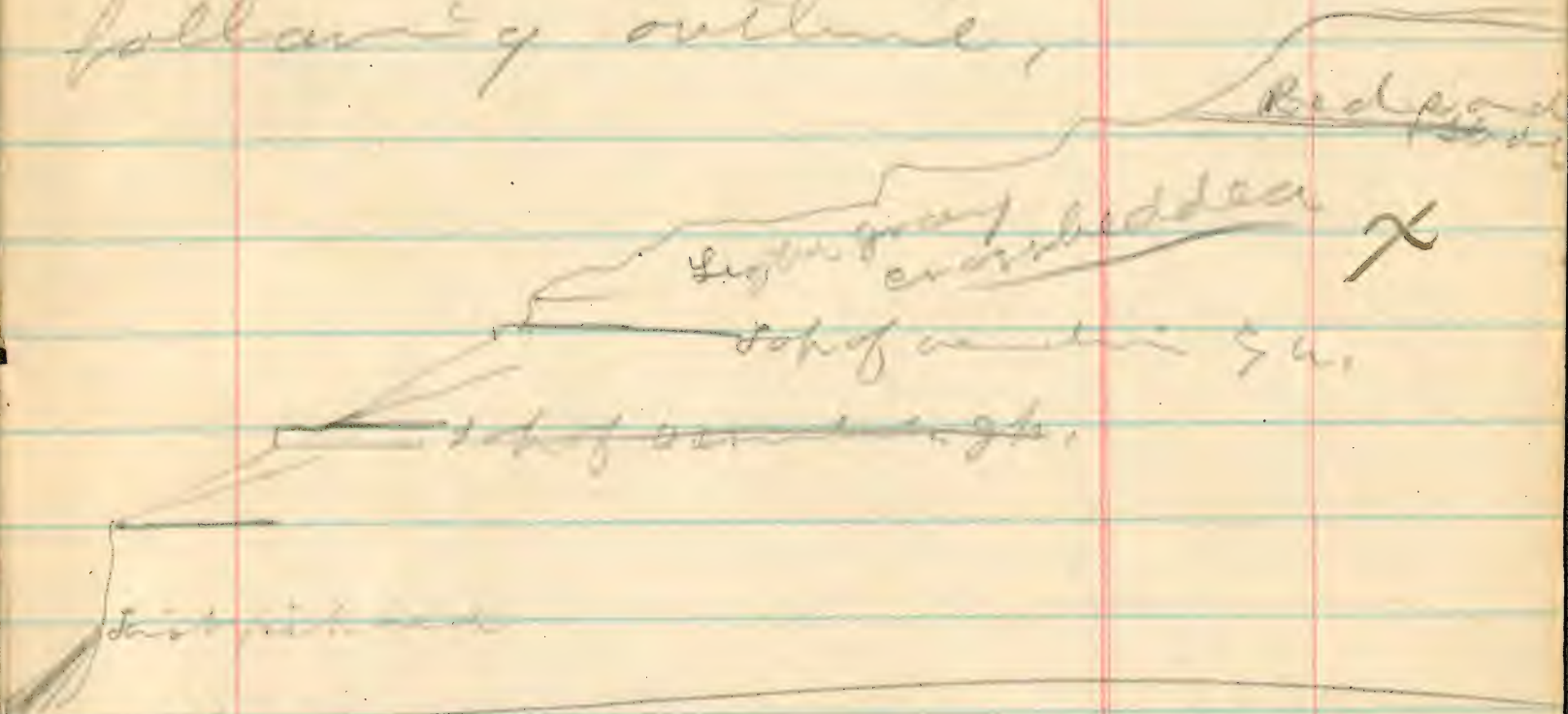
There are some beautiful illustrations of cross-bedding in this upper portion, especially the curving lines crossing obliquely across the other strata.



Saw evidences of coarse pebbles in the lower portion.  
Above this there is a dark red sandstone + fine shale intercalated.  
There is a very long long distance in the canyon between the light colored sandstones above & below.

Thickness 120 feet.  
The upper portion is more indurated  
than the lower portion.

(15)  
a view of the west cliff at the mouth of the Kanab Canyon Vermilion Cliffs, presents the following outline,



The white sandstone is divided into six principal beds by subhorizontal partings of more indurated shaly sandstone, which separate the cross-bedded massive layers. The latter are not of uniform thickness at all places, varying from 30 to 60 feet but the divisions are readily seen on all mural cliffs.

Aug 27<sup>th</sup>



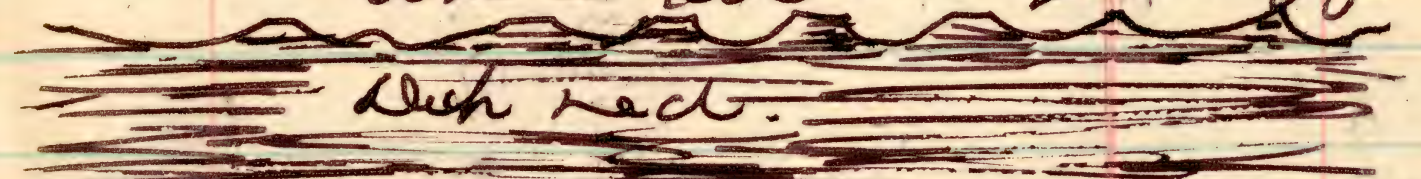
(16)

Tracing the red bed in the main canon & also in many of the lateral canons it is seen to be a uniformly bedded deposit. A number of thick layers alternate with the chaly beds until towards the summit where the thick beds are indurated & present a strong dark brown colored band beneath a ~~deposit~~ stratum of (horizontal) light colored gray sandstone which is succeeded by curved & twisted layers & then by the crossbedded sandstone. This red bed is a result of the ~~confirmation~~ of the conditions which formed the red beds of the Shinarump & Vermilion cliff lps. In the Kanab & lateral canons it is usually capped with a layer of calcareous sandstone. All the strong ~~features~~ of the canon arise from

(17)

appear from this horizon.

Continuation of section above red bed. Aug 28<sup>th</sup> 79. The red bed is ~~succeeded~~ <sup>capped</sup> by a coarsely deposited layer of fine grained <sup>dark</sup> red sd. usually streaked with white from the cliffs above. The upper surface of this stratum presents the following aspect when exposed on a freshly broken surface. ~~at other places it is seen~~

White bed on higher bluff  


The two beds were closely & intimately united showing that the white sand followed the red with-out ~~an~~ <sup>an</sup> ~~interval~~ <sup>interval</sup> of time.

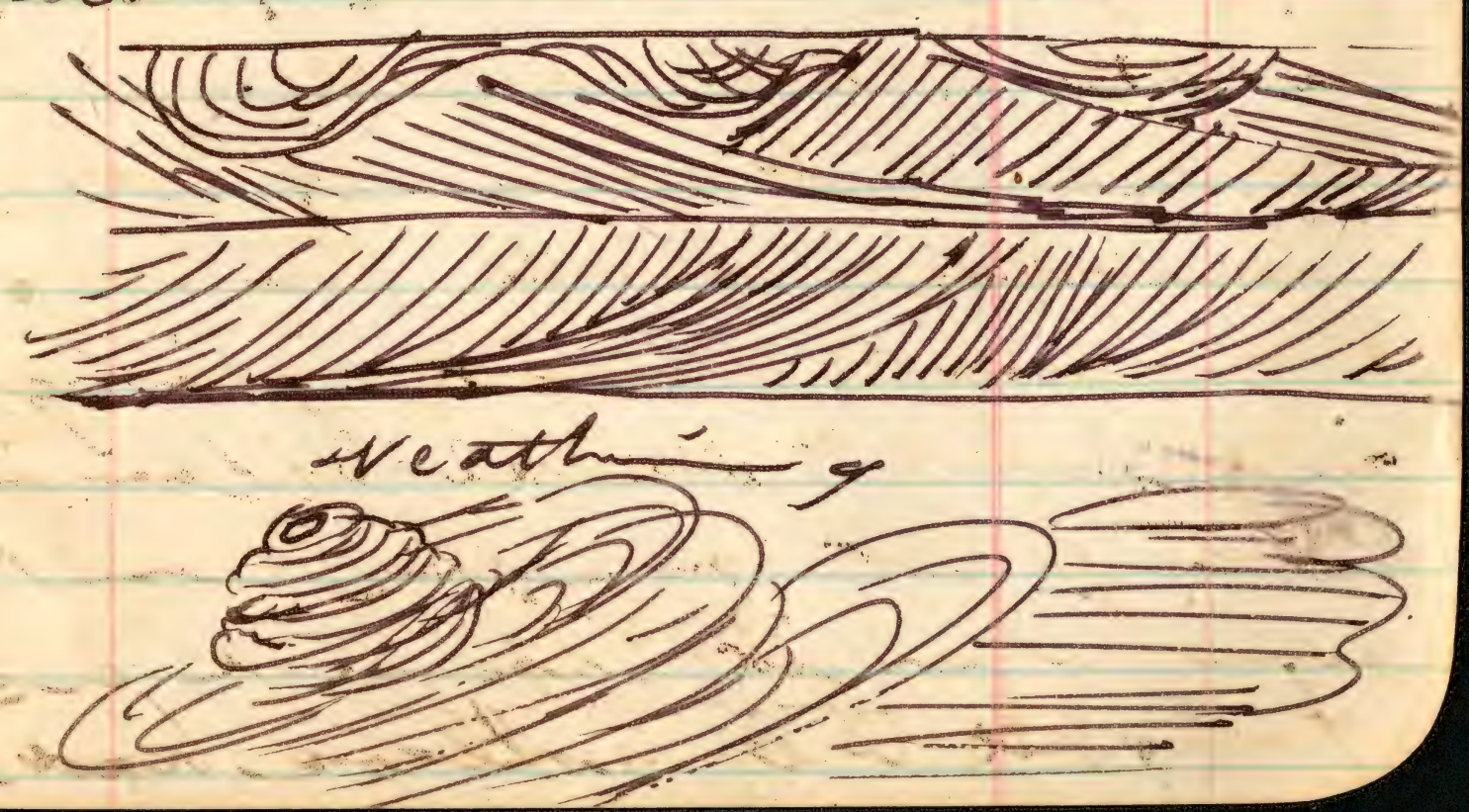
The buff bed is succeeded by a mass of beautifully banded ~~micaceous~~ & buff sds. cross & evenly bedded.

Next comes a great mass of reddish & whitish cal. sds



They extend to the vermilion colored beds beneath the white cliff. They are composed of several thick bands divided by horizontal ~~surface~~ lines separating it into beds of from 25 to 100 feet. The beds are composed of evenly bedded layers of from 1/8 to 1 in thickness. The thinner layers predominating. Occasionally a thicker layer (4 to 12 feet) occurs but it is usually irregular & of slight horizontal extent. At various places in the strata, usually near the summit of one of the crossbedded bands the layers & curved & twisted, giving a gnarled & knotted appearance. The first examples were seen when it appeared as though the hollow had

of an uneven sealed hard then filled up & leveled off to make way for the floor for the air conditioning stratum. Thickness of beds from Red bed to vermilion beds at base of great white cliff stratum. 420. Vermilion bed in flat. 700. To base of White sd in cliff 1120. The buff, gray & reddish brown layers are intermingled & also deposited in irregular bands. The deep red Vermilion beds predominate towards the summit of the mass. 350 feet above the base red bed.





The <sup>5<sup>th</sup></sup> 700 feet of strata crossing the interval between the headwaters of Kanab creek (springs below White cliffs) is c. b. s. d. red, brassy red, vermilion with an occasional fillet of white. The upper portion merges into the white cliff sed by an irregular line of contact & union, the change is in the color.

The upper 400 feet is mostly of a vermilion hue & is a soft easily disintegrated s. d. sand. Low foothills below the cliffs. The <sup>white</sup> cliffs all present a mural surface to the south and large masses are separated as buttes. Above the vermilion bed, which is a somewhat fluctuating horizon the true light gray or white cliff forms

Massive light colored divided into fine principal beds each consisting of fine. crossbeds 575 feet.

Capping sandstone of a reddish hue. 100 feet. Upon this rests a limestone containing fossils.

Notes of white cliff sandstone.



Section II. Upper Kanab.  
Buff sandstones etc directly  
west of Pink Cliffs.

(1)

a. Buff sandstones (hard) alternating with clays & marls.

a. Marls & sandstones: hard  
and not readily disintegrating.  $\frac{30}{25}$  feet  
b. Hard buff sand 20 "

c. Alternating bands of marl or  
clay (weathering of purple. lead  
color & white or light gray)  
& buff sandstone 100.  
at this point found fresh  
water shells in a bed of  
light clay. 20 heavy bedded  
Buff sd  $\frac{30}{170}$ .

d. Heavy beds of buff sd. 30.  
with fossil shells &  
plants.



8. Light layer of sd + 60  
clay

f Heavy bedded buff sd with  
fossils. The fossils  
occur in a calciferous sd  
which occurs in a some-  
what irregular beds near  
the summit of the mass and  
also again 50 or 60 feet  
above the clay bed beneath.  
Thickness to clay bed of

155 feet

g An irregular bed of clay  
+ fine buff sd. Clay lead  
color contains fossils.  
Plants remain 10 feet.

h massive buff sd 8 "

i clay + sd as h)  
"layers containing  
beams, first a few shells  
at base in dark clay 12 "

j massive sand buff 15 "

k Soft fine sand with  
purplish clay beneath  
holding fossils. 30

l massive buff sd with  
a parting of clay. 25

m White sand with  
bed of fine conglomerate  
near the summit 170

The section down to the <sup>white</sup> sand  
+ conglomerate is an alterna-  
tion of buff sandstones with  
clay bands. Occasional  
calciferous layers, persistent  
only for short distances, still  
seen on the same horizon  
at different localities and  
met with holding fossils  
Fossils also occur in the  
sandy layers but only



usually in poor condition  
 + liable to be broken in getting  
 things out. The ~~matrix~~ <sup>matrix</sup> of  
 fine yellow sand & clay is  
 the best matrix for shells  
 etc. The bluish or black  
 colored clay weathers to a  
 light gray & stains the cliffs  
~~that~~ below. The conglomerate  
 at the summit of the  
 is from 15 to 20 feet in thickness  
 & as persistent as far as ~~any~~  
 examination has yet been  
 made. The light gray or  
 white sand disintegrates  
 easily & has caused the  
 cliff ~~back~~ so that the  
 exposure of the upper  
 rocks is but a narrow  
 ridge of the debris.

(N)

At the base of the <sup>white</sup> sand  
 there is a heavy <sup>iron stained</sup> ~~buff~~ <sup>flashed</sup>  
 15 to 25 feet followed by alter-  
 nating shales & clays for  
 a long distance. The clays  
 have undrained the sands  
 & rendered an accurate  
 division of each im-  
 practical.

Beffs are ~~thick~~ beds with  
 marlon clay parting & to  
 15 feet in thickness.

Fossils bones fragments  
 remain are scattered  
 through the sandstones. Fossils  
 were taken at 375 feet below  
 white sandstone (Frank's d  
 n 375.) <sup>(500 to 600 feet of white hill)</sup>

Below the 500 foot level  
 the rocks become more shaly  
 for the succeeding 200 feet.  
 A heavy yellowish or sandy  
 buff stratum, partially decomposed  
 layers are common 500 feet



Below white sd - 800.  
This is followed by a coarse  
sd. yellow, iron stained in  
narrow bands & below white  
or gray, a few pebbles  
are scattered in the coarse  
upper sand. 75

The disintegration of the  
white sand leaves an  
escompoist black which  
is prominent in all the  
hill sides. It is the top of  
the *Astrea* bed.

The upper sandy shales  
(10 feet) contain few shells.  
Below a small species is  
found with a few of the  
narrow elongate form  
& also *Agnellonchites*,  
*Gastropods* etc. 25 feet.

The ~~ore~~ *ore* bed, yellow sand  
filled in places with  
the shells lies below,  
40 feet.

The central portion is a  
soft yellow sd & in the  
elongate *Astrea* is so thickly  
placed (mouth up) that the shells  
touch each in in great masses.  
This bed is from 2 to 6 feet in  
thickness & persistent as far  
as yet examined. *Exogyra*  
was seen lower in the  
bed but was not seen with  
the elongate form. A curious  
commingling of fossils occurs  
in the 40 foot bed. (Recollections).

Childs & Kite on (M. Sept 27<sup>th</sup> 79)  
Above the *Astrea* bed  
there is a bed of  
bituminous shale with  
a few thin seams of coal.  
This passes up into an arg.  
shale then in soft white  
sandstone.



Snix Valley Camp. Sept 15<sup>th</sup>  
7 A.M. 7550.

a 9200. Base of Caring

b. 9050. Base of b.

c 8875 175  
Base of c.

Adding with 30 to 8875 = 8975  
d. 8850 - 125

with 25  
125  
25  
150

8850  
c. 8875 - 275 + 25 = 300  
Base Hill 8600.

Top of hill, base of f. 1/2 mile  
south 8625

Line with strata in hill next  
east 8125. Top of Henryland  
of Buff sd. 7925.  
with 250

700  
250  
950+

7925

# Sect 3117

Section north of Claborn  
Sept 15. 1879.

Pine limestone

Handstone grayish colored  
Pine by wash from limestone  
Conglomerate at base 50 feet

a 50  
Incubated sandstone.

yellowish brown 15

b  
Light colored sandstone at base  
with portions of lead to  
purplish colored clay sandstone.  
150

c Buff sd. massive in layers  
+ also shaly in many with  
slight portions of marl. 175

d. Massive buff sd. 20 feet  
underlain by buff sd  
+ a thin bed of marl intercalated  
at intervals. 150.

e. Buff sd with Calcareous  
stratum carrying fossils. 10.



30  
strata below bed on like  
valley sides.

Massive sd followed  
by clay etc. Slide not  
continue in side valley but  
went 3 miles east.

Sect 3117  
Section north of Clark Co.  
Sept 15. 1879.

Pink limestone

Handstone grayish, colored  
pink by wash from limestone  
conglomerate at base 50 feet.

50

Inclined sandstone.

yellowish brown

15

Light colored sandstone, at times  
with part of lead &  
purple colored clay sandstone.

150

c Buff sd, massive in layers  
+ also shaly in places with  
slight partings of marl. 175

d. Massive buff sd 25 feet  
underlain by buff sd  
+ a thin bed of marl intercalated  
at intervals. 100.

e. Buff sd with Calcareous  
stratification, fossils. 10.

7925



Below this there is a succession of massive buff sds with clay parting, denoted by weathered clay on sloping outcrops on hill side to a massive buff sd stratum 25 feet thick which rest immediately above a fine conglomerate & white sandstone. 300.

The white sandstone with the fine conglomerate at 150 the base extends down to a heavy dark buff layer 140.

Below this there is a succession of buff sds with a few clay beds the lower central portion is more shaly & below a white coarse sandstone zone. 860

g. At 191 a yellow sand contains an elongated form of *Astraea*. Numerous shells occur in a layer above & below. 40.

h. ~~Massive buff sd~~ are half mile south the same bed is intermittent. fossils. It has the same lithological character but along an outcrop of 2 miles no fossils were seen.

i. Massive buff sandstone 50

i. Soft sandy layers passing into an ancon shale & then into argillaceous shale with a semi bituminous argillaceous shale with coralline nodules (near the base) 785 feet



Red shale breaking into  
angular fragments 10 feet

The red shale contains

Soft sandstone, buff with  
an intercalated mass of  
laminated red shale in a  
matrix of volcanic matter. The shale is broken  
and is embedded in the  
sandy sandstone at all angles  
and in every shape. The  
mass is two feet thick  
in places.

Section below not  
taken.

Comparatively few fossils  
being seen in the line  
of this section both the  
limestone and the red shale  
were devoid of fossils with  
slight exception.

Note on strata above bed  
above the massive sandstone  
of the Astrea bed there is an  
exposure north of Lookout  
an argillaceous shale with  
a bed of dark brown shale  
six feet from the base which  
contains crystals of selenite  
and fossil shells. A bituminous  
shale occurs above it and  
then an argillaceous shale  
passing in places to  
that of a thick bed of  
sandstone 50

100 feet  
~~100 feet~~

Nearly the same mass in  
occurs above the Astrea bed  
in the Kanab Canon. Examined  
on a north outcrop. Sept  
27<sup>th</sup> 1879.



36

37



Section on east side of  
Sink valley, continued across  
from west side.

Top of Jurassic limestone  
1 Red mud with conglomerate <sup>159</sup>  
~~200~~ feet

2 Gypsum, white nearly solid  
mass 30

3 Conglomerate followed  
by red mud ~~200~~ 200

4 White ~~conglomerate~~  
mud - <sup>150</sup>  
~~150~~

5 Brown shale 2 feet.

4-x 1/10 sand (all shale)

6 Cream anhydrous  
mud - <sup>275</sup>  
~~150~~

7 White sand streaked  
with yellow, 75

This is capped by a thin  
conglomerate of varying

thickness. In a distance of  
100 feet it changes from a thickness  
of 1 foot to six. The sandstone  
immediately underlying it seen  
at sink valley may be present  
as a ten foot band of light  
buff sandstone on solid layers  
or broken up in several thin  
layers - all not three feet thick,  
a few yards away, or entirely  
absent as on the Kanab valley  
side just below Linc's old  
place. The strata above are  
also very variable. The coal  
seams are not at all persistent  
and the sandstone very very  
much in thickness.

No 7 is a variable bed. The  
mud beneath one more  
persistent & uniform along  
long lines of outcrop.

From my present view I should  
place all the mud in the



5540 m

Carbonaceous restricting the  
Jurassic to the 215 feet of limestone  
and sandstone

Jurassic

- 1. Sandstone in white cliffs. Summit of White Cliffs sandstone.
- 2. Buff or cream colored fine grained calcareous sh. evenly bedded in layers from 1/2 to 2 feet in thickness. Ripped and broken and resting on coarse orange-bedded light gray sd. 5540
- 3. Shaly layer sd 60 65
- 4. Limestone band 10
- 5. Shale sandy + massy shaly, sandy layers 50 25
- 6. Cream colored limestone with fossils 25
- 7. Reddish gypsiferous marl 25 50  
See pg 30
- 8. Coarse conglomerate formed of the fragments



rounded, rolled sandstone  
limestone. siliceous pebbles  
etc. principal <sup>siliceous wood,</sup> calcareous  
cement with some sand.

h. 115.

Bed of gypsum with much  
gypsum in thick layers 30

i. Low redish mud hills <sup>all mud in places</sup>  
with remains of con-  
glomerate on the sides  
indicating decomposed  
conglomerate. 200.

White below  
col 10-20 ft

Arenaceous. gypsiferous  
mud. cream colored.  
banded with red & greenish  
arenaceous bands. Capped  
with a yellow unbuffed 325

k. The sand is about 2 feet  
in thickness & holds  
leaves etc. this is followed  
by a band of clay, dark

from cutaneous vegetable  
matter & weathering to a  
pinkish purplish hue.

240 feet

h. Another band of yellow  
sand followed by light  
colored sand in some  
places with a dark band  
of clay no coal found. <sup>dark sand on surface</sup> 20

k<sup>2</sup> Yellow sandstone weathering  
white with a dark argilla-  
ceous shale with a band of  
impure lignitic coal, with  
shaly partings. 4 feet thick  
succeeded by a thin grey  
mass of partially carbonized  
vegetable matter. 25.

h. Yellow irregularly laminated  
band of sandstone 3 feet  
followed by arenaceous  
clay band, dark weathering  
dark 25



44  
L. Massive, partially c.b.  
buff sandstone below same  
minutely bedded certainly &  
hard calciferous layers  
very irregular oval.  
Contains leaves etc. 45  
Shales dark brown parting  
with a thin seam of dark  
shale occur near the  
upper portion between the  
thick layers of red 45.

M. Argillaceous shales. Hardening  
into layers of from 2 to 8 in  
thickness, breaking in angular  
fragments. Contains shells  
etc. 30 feet from summit of  
this bed there is a seam  
of coal 3 feet thick & 6 feet  
below another of 3 feet.  
Clay shales beneath each.  
To next buff red 60

45  
N. Heavy buff red. Soft near  
base & more indurated above  
scattered bones occur in the  
lower portion. The upper  
layer is a deep yellow. This  
top of hill covered with  
volcanic matter.  
To top of red 25 50

O. 10 feet of bituminous shale  
followed by a light colored  
sandstone holding numerous  
fossils 20 feet. Up to the  
present examination of  
over 5 miles of outcrop  
on the line of Kanab valley  
there is here a seamaceous  
layer of volcanic matter  
which follows the line  
of red shale which  
holds some fossils as  
in sand below. This  
is succeeded by a white  
sandstone in thick

The interesting volcanic matter - 1000  
occurs in the same position in the  
lower side of Kanab valley.



96  
irregular layers of  
feet.

Bituminous, argillaceous  
shale with concretions  
modules containing *Ammonites*  
*Baculites* etc. etc. <sup>Small *Exogyra*</sup>  
in section. 80

97  
10 feet of drab colored  
gypsiferous mud followed by  
90 feet of soft yellow sandy  
shale which is capped with  
harder sandstone at top 108.

Note. It is more argillaceous than  
bituminous. The modules contain-  
ing the fossils vary from 3 in to  
2 feet in diameter & are usually  
flattened. They occur about  
20 feet from the base above  
there is another stratum of  
modules of a more crystalline  
character with but few  
contained fossils.

97  
The sandy shale continues  
across the low flat between  
the South & North sides of the  
road leading from Kanab  
to Link Valley and is again  
taken up in the foot hills on  
slopes of the hills to the north.  
Concealed partially, soft sand  
shales & arenaceous clays  
ca. 150 feet. (Estimated)  
75 feet of arenaceous shale &  
then there is 475 feet of 200  
feet of drab colored argillaceous  
shales followed by 275 feet  
of arenaceous shale with  
argillaceous bands the  
shale marked by fragments  
of vegetable matter thin  
places slightly gypsiferous  
The upper portion changes  
into a fine sandy shale  
with a drab clay  
top.

750.



Massive buff sand  
underlying Ast. bed  
50.

Note for Q. On the pink  
valley side there is a layer  
stratum of soft coal 4 to 6  
feet thick beneath the  
sandstone in the bituminous  
shale. It was also seen  
in a ravine on the Kanak  
side above River discharge.

Note on sp. The nodules with  
fossils were found at the  
same geological horizon  
on the Pink Valley side.

When exposed to the weather  
the nodules break & for it  
many pieces being a soft  
crust. The small pebbles  
fragments can then grow  
on many small knolls  
little.

Partial section of lower  
coal bed. Pink valley  
side resting on white sand-  
stone which passes down  
into arenaceous clays etc.

1	Buff sand	2
2	Bituminous shale	30
3	Sandstone	2
4	Arenaceous shale	20
5	Dark bitu' shale	12
6	Clay bed	3
7	Coal seam. Dark green. Light brownish coal on passing into brown lignite	9
8	Chy shale. brown to dark	10



9	Limestone	1
10	arenaceous clay	23
11	Shale	5
12	Gypsiferous clay	23
13	Coal	15
14	Ar + arg shale	45
15	Red	10
		197

This corresponds to K. 1234 etc of section from the Jurassic up taken on the Kanab valley side. The upper coal beds of that section are circled in this. K<sup>2</sup> contains the coal seams (7).

Section from the summit of the White Cliffs on the west side of the Kanab Canon.

Jurassic.

a. Limestone, mainly bedded, gray, very hard, little frag. under the hammer. Contains fossils in the lower shaly layers.

b. Limestone. Crossbedded gray + purple, marked with dendrites passing down into a limestone band and again sandstone to the top of the w.c. limestone.

The purple gives way to white + the yellow comes beneath. Dunes are not determined owing to this

c. Solid Cliff w.c. b. red.



b. Vermilion bedded c.b. soft  
readily disintegrating, etc.  
extending across valley.  
600 — 700

c. Gray to red band c.b.  
red massive & bedded  
in bands from 25 to  
100 feet. 300

d. Red evenly bedded  
Red - c Red bed (8 measurements) 125

e. See pg 16  
Gray sandstone to  
red band. ~~is same~~ 320.

f. See pg 15.

g. evenly bedded.  
f. g. Massive stratum  
partially c. b. 20

g. h. Light red color  
evenly bedded sd  
with thin layers  
of gray sandstone 20

i. Dark red sandstone  
massive layers alternating  
with shale. soft to  
disintegrates easily  
forming a sloping  
talus above the gray  
sd beneath (pg 12) 180

j. Light gray sd 5

k. Bedded sandstones  
varying in various  
shades of red & gray.  
The layers are  
irregular in thickness  
and some bedded  
fragments of less in-  
dicated sd. 230.

l. Thin layers of sandstone  
alternating with beds  
of argillaceous shale  
holds fish teeth etc 20



m l massive, reddish brownish layers. 50

n m Alternation of sandstone layers + argillaceous shales holding fish remains etc. 25

p n Blue + sandy shales with thin layers of sandstone Pg 8.

a n Reddish brown sd easily disintegrating with fragments of shale breaking into layers of from one to six feet in thickness. 120

f o Muds + shales with beds of sd. Pg 7. 70

g h Reddish brown sd with white band above. 20

285.

Shale.

a shale, grayish brown. Dense, fine grained, green + bluish green disintegrating forming low foothills. 650.

b Gray Conglomerate Pg 6. 50

c Reddish brown shale 30

d Massive layers sd separated by fine sh. Pg 1. 50

e Brown soft shale gyphaceous. 105 90

f Light colored arg. shales. Top 5550 Top 5450 with 25 125 120

g Red gyph shale 1300 100



h. ~~Impure~~ limestone  
holding cast of fossils  
and also in the pure  
limestone well preserved  
shells. Gastropods brachi-  
opods and lamellibranchs.

i. Red mud

4<sup>th</sup> 6

15<sup>th</sup> 40

j. Impure limestone with  
indurated gypsiferous  
shale beneath.

k. Red gypsiferous shale.

l. Impure limestone slaty  
beneath (see pg 58) 2<sup>nd</sup> 13.

m. White mud 2 feet with  
6 or 8 feet of (see pg 58) 70

Iron west side is composed of just  
gyp mud & thrust alternating.  
Solid on Butte in east side

On the west side of the  
Kanal wash just before  
reaching the opening of  
the Canon. The limestone  
at the base of the Phreatic  
gph rises to the east and  
south.



outlying butte is not affected  
by the uplift. It is a local  
area of disturbance. There  
are other indications of  
disturbance but too slight  
to be determined as to dip  
etc.



(1st  
Crest)



h. ~~Impure~~ limestone holding cast of fossils and also in the pure limestone well preserved shells. Gastropods brachiopods and lamellibranchs.

i. Red mud 4 1/2 6  
15 40

j. Impure limestone with indurated gyphiferous shale beneath.

k. Red gyphiferous shale.

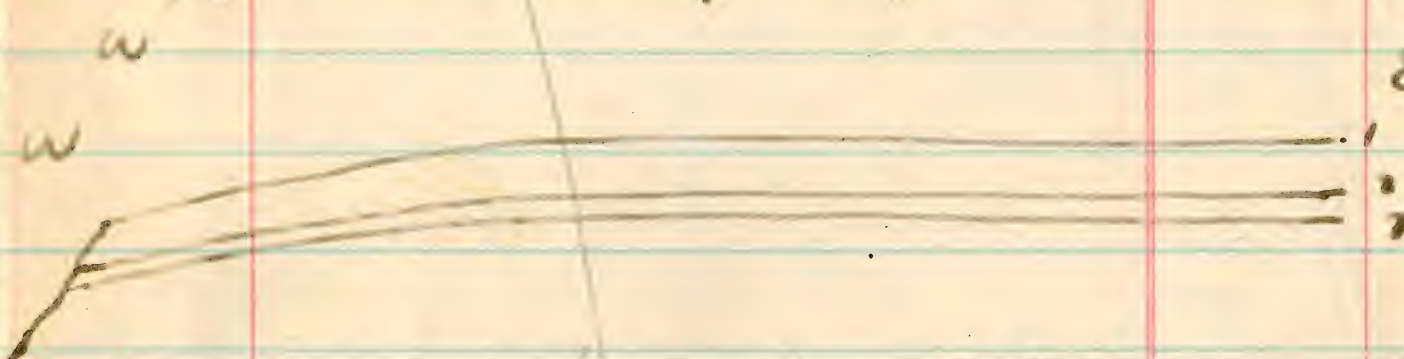
l. Impure limestone shaly beneath (see pg 58) 25 10.

m. White mud 2 feet with or below (see pg 58) 70

On west side is composed of just gyph mud + thrust alternating. Solid on Butte in east side

Note.

The limestone capping the low cliffs south of the Shinarump conglomerate on the west side of the Kanab wash, extends down to the western margin of the cliff indicating a fold and



fault as the Shinarump conglomerate.

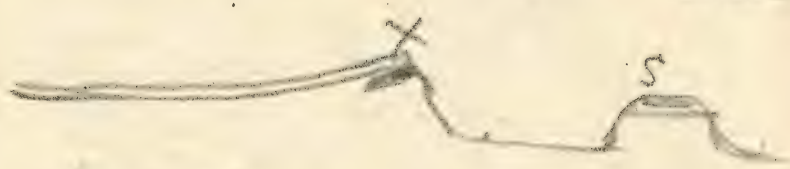
The general dip of the undisturbed strata is

viewed from further east south the strata is seen to be the western end of a synclinal anticlinal arch. The entire structure is as follows.

The west side of the Butte is a low ridge with a gentle slope to the west.



On the west side of the  
 Kanab wash just before  
 reaching the opening of  
 the Canon. The limestone  
 at the base of the Phosphatic  
 Gp. rises to the east and  
 south.



nothing further are not affected  
 by the uplift. It is a local  
 area of disturbance. There  
 are other indications of  
 disturbance but too slight  
 to be determined as to dip  
 etc.



(S).

(1st  
 Curve)



Shin Gh.

dātumbura

---

Shin Gh. dātumbura  
head of Shin Gh. dātumbura



the line representing the line of the sandstone

East

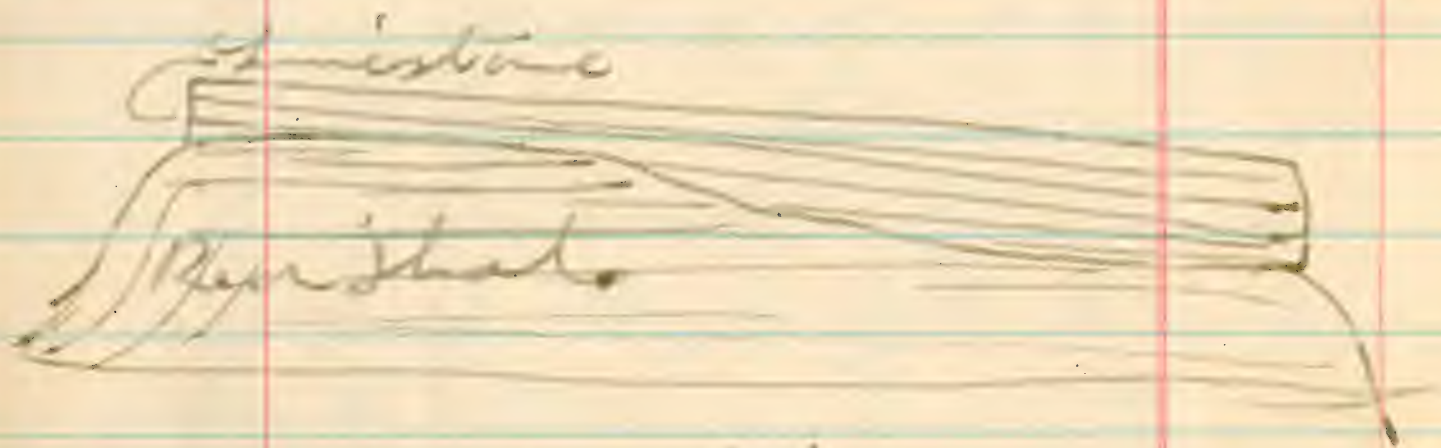
as at the western margin of the cliff the dip is at the  
strata then curve upward in a very gentle slope to  
ward then down to the east forming a low  
synclinal at C. as there is a gradual rise  
to the east of C. followed to the north by the  
usual dip of all the strata. The western side

of the western dip may be seen by looking  
north for a long distance across the plain  
towards the south of the canyon. A cross section  
south of the canyon  $x = 11$   
showing a cross like view of the canyon  
the dip is from east to west

the flat south of the plain  
is broad and with the exception  
of low outlying buttes south  
of the line the work  
is a small river broad and  
extends out to the canyon  
ous escarpment where it  
is stretches as far as the  
line of sight. a few  
mountain tops appearing on  
the far to the south. To the  
north the river is the first  
seen of the kind. The river is  
cliffs present a bold  
bold. The adobe & sandstone  
having deep canyons that add  
to the varied surface by presenting  
the wide views of the terraced  
cliff. Below the low cliff  
of the plain, Cong. red sandstone  
capped with white of the  
one great line of ~~flat~~ <sup>low</sup> ~~flat~~ <sup>low</sup>  
level terraces. One from  
best looking like a great  
man chads resting on the



of page 54. rest on the eroded surface of the red shale beneath. This is well shown in the outlying buttes on the east side of the wash south of the cliffs.



It varies in thickness from 10 to 30 feet. Contains many fossils. The upper portion is a sandstone holding large lamellibranch shells. 1/2 mile N.W. the limestone is not over 1 foot thick but a thick band of gypsum & arenaceous shales replace it. near the base a few sandy layers 2 to 6" thick hold lamellibranch shells.

The fossils occur in the upper limestone, sandstone, arenaceous shale with gypsum. laminated layers alternating of gypsum & sand & argillaceous shale. In the argillaceous limestone with fossils replaced by gypsum.

A section on the west side of the Kanab wash taken from the base of the Lhamanah Conglomerate.

The upper surface of the shale was eroded prior to the deposition of the overlying conglomerate as may be seen in most good exposures of the line of contact of the Conglomerate and shaly sandstone.

The entire section was carefully measured with the exception of 75 feet of the lower red soil.



The conglomerate at the point where the section was taken is darker than usual and in fact is a very dark red color for a mile or more along the exposure at the lower beds the upper in many places being a nearly pure white sandstone c.b. The pebbles are all agatized. No fossil wood was seen at this point.

c.d.  
Shaly sandstone, dark red with brown passing 20 feet from the summit into a massive sandstone. Pipple marks & mud cracks occur in the shaly portion 135.

This is the c.b. of section (Chinamp).

2<sup>d</sup> Dark red arenaceous shales with seams of gypsum.

running thro' it, both horizontal and vertical 105  
3<sup>d</sup> of section.

Gray gypsiferous mud, arenaceous, with bands of red color near the base 125  
4<sup>th</sup> of section.

Red <sup>arenaceous</sup> gypsiferous mud, Col. sandy shale more indurated near the summit 300  
Measured 225 feet estimated 75 by barometer & dip.

5<sup>th</sup> Impure limestone holding fossils. Gasteropods at this point 4

6<sup>th</sup> 1  
Red gypsiferous mud 15

7<sup>th</sup> Shaly impure limestone varying from 2 to 3 feet



with arenaceous gypsiferous shale beneath. A few of the sandy layers increasing to 4 or 6 ft in thickness and holding fossils a band of red mud separates this from a somewhat similar shale and limestone beneath. On an outlying butte on the east side the entire band is limestone the lower stratum being five feet in thickness. 25.

This last bed is of varying thickness as it rests on the uneven surface of the gypsiferous sandstone beneath which shows erosion.

Section continued on west side.

8 Red gypsiferous mud with arenaceous shale. No fossils. Some bones found near summit. 108

9 Yellowish sandstone with red gypsiferous shale beneath 4 to 6 feet. 37

10 Chocolate colored limestone containing cast of fossils and also a few faintly preserved specimens 15 to 25

11 Cream colored limestone with red fossils in upper portion. Small chert nodules. 25

12 Cream colored shaly limestone. 32

13 Limestone gray to yellow with much chert. 31



14' cherty limestone. chert  
in large, <sup>round</sup> masses, weather-  
ing black.

Contains numerous  
fossils. *Podoceras atropis*  
etc.

85

Section of the canon walls. East  
side at the first alkaline  
springs.

Green limestone with red  
fossils 11. of from our section.  
Thence to the summit of the  
cliff at this point to the massive  
cherty limestone the strata  
are much broken up by  
irregular bedding, the  
presence of sandstone and  
the irregular distribution  
of the chert.

150

Massive bedded cherty  
limestone

200

a fault crosses it & the  
section was discontinued.

2-1/2 / 12 1/2 /  
100 / 12 /  
147



Section of Cliff below Abner's  
Cave.

1. Red fossil bed with  
characteristic fossils caps  
the cliff. Beneath this the  
beds recognized to the north  
as limestone with sandstone  
beds are 4/5 arenaceous  
rock with chert & some  
limestone 200 feet

2. Massive cherty limestone  
beds 100 below by cliff.

North 1 mile.

are indicated from sandstone  
caps the cliff back from its  
edge a short distance.

1. Cherty limestone with a  
large proportion of sand

2. Massive bedded cherty  
limestone 150 250

See note pg 76.

Base of red bed 4950  
Top of red bed 5725  
875

Sandstone with Calceolaria  
red in layers intercalated.  
70

Top of limestone 5975  
Base 5725

150  
70  
220  
25  
245  
19

250  
25  
245  
19

Top of red bed 4.4 6100  
125

Gybed 125

Shady limestone, yellow passing  
to gray & wh to cherty. 65.  
Holds many fossils -

6200

Massive cherty  
Top 6425

225  
25  
250

+ Top cherty bed  
stone & containing many

65

125

77



Section  
Cannon.

0 11  
22

1. Red from  
character  
the cliff.  
beds recog  
as first  
bed and are  
rock with  
limestone

2. Massive  
beds

North  
an island  
Cape the c  
edge a sh.  
Cherty  
large frag

2. Massive  
limestone

3 Cherty limestone thin  
beds passing to calcareous  
sandstone and yellow  
sandstone. Holds  
fossils in calcareous  
portion.

65

3 Gypsum bed with  
alternation of friable  
sandstone

125

4 Cream colored limestone  
passing gray to a  
arenaceous limestone and  
to sandstone. (Cherty) 85

6 Sandstone with light  
gray, with cast of fossils (Cherty)  
Productus etc 140

Light colored sand with  
calcareous layers. Then  
into somewhat thin  
layers then the mass  
stone containing more



sandstone. 45 40  
 d. Gray c.b. sandstone 30  
 5 245  
 6 Deep red bedded sand  
 with shaly friable  
 partings 235

Partially c.b. deep red  
 sd 20-30 feet passing  
 into evenly bedded as  
 above 270

c. Layer of gray sd followed  
 by somewhat massive  
 strata interbedded by little  
 shale (deep red) 250

measured by barometer & 775.  
 Deo Locke level. each  
 gave 775.

b & d was a c.b. gray sd  
 as an opposite cliff 100  
 feet.

Section of Massine s.b. sd below  
 4 miles below.

6. Massine bedded c.b. sd.  
 L.L. — — — 315.

This is a variable bed in  
 color. Just after it makes  
 its appearance in the canon  
 the upper stratum is gray  
 to buff with deep red partings.  
 Then massive beds of a  
 purplish hue and again  
 reddish. Fine m.b. below  
 the purple predominates  
 at the summit and the gray  
 red & buff below. It is a  
 great mass with out any  
 regular divisions in color  
 or stratification. Near  
 the summit a stratum of  
 shaly limestone is in-  
 calated at one locality  
 for a few hundred yards.  
 This is also repeated at



at the central portion of  
 some some c.b. strata are  
 somewhat calciferous.  
 As a whole the gray color  
 predominates at the summit  
 then buff followed by  
 purple and redish hues.

7

Alternating purple and  
 redish bedded sandstones.  
 Black carbonaceous may be present  
 in some bands or layers.  
 A band of 20 feet may be  
 purple & further on redish.

Limestone occurs in nodules  
 & also in shaly partings  
 with friable sandstone.

The more massive beds vary  
 as to thickness. The c.b. and  
 color.

L. 4,

16

Bar 150.

8

Gray c.b. sd. upper surface  
 somewhat irregular.

72

8. Purple sd. partially c.b.  
 with shaly limestone  
 at the top.

25

5

Massive c.b. buff colored  
 sd.

58

L. 9.

155

Bar 150

9 Purple sandstone mas-  
 sive c.b.

10.



Note for 2. pg 66:

A careful measurement with  
locks level gives of the massive  
chert bed on the east side 2 mile  
east of the section a huge 66  
gave 265 feet for the massive  
chert this included about 15  
feet of the lower <sup>and</sup> cherty beds  
which were included in the  
beds below. The formation  
gave 250 feet.

Note on 3. pg 67.

Near the upper portion  
there are several beds  
strongly bituminous and are  
layers 2 to 6 in in thickness.

Small brachiopod shells occur  
on west side.

At this point 1 mile below  
Chimney on east side  
the same beds. Top of limestone  
massive cherty is a level  
with thickness 150 above on

the west side. As seen with  
locks level.

The limestone beneath the  
upper bed is somewhat shaly  
for a few feet but rapidly passes  
down to the thicker cream  
colored magnesian limestone.  
There is more sandstone on  
the east side and the mass  
as a whole is thicker by 80  
feet than the same on the west  
side.



74 Oct 22<sup>nd</sup> 79.

1/4 mile above mouth of Hondo  
Canyon on the Colorado.

1 Massive indurated red  
garnetiferous. 20

2 Greenish micaceous <sup>or</sup> shale and  
passing up into calciferous  
sandrock and to mottled  
gray limestone (trilobites) 30

3 Greenish arenaceous and  
micaceous shale (trilobites) 115

4 Gray limestone alternating with  
arenaceous shale  
passing into mottled limestone  
Passage beds to the mottled  
limestone 70

5 Primitive trilobites, corals  
& coralline markings.

Lower Kanab <sup>3<sup>rd</sup></sup> Canon, west side  
3 miles from the Colorado.

1. Calciferous sandrock at top and  
base, buff sandstone between.  
Thin weather black and all  
is stained a redish hue by  
the wash from above. 35 feet

2. Gray and drab colored lime-  
stone, rather predominating to  
very hard, brittle, breaking  
into angular fragments.  
The gray limestone, sandy  
partings occur at all levels  
and there is much arenaceous  
matter intermingled with the  
limestone. The gray limestone  
is in layers of varying  
thickness 1/2 in to a foot. Usually  
contains many small flat  
concretions. The upper part  
of 50 feet to the first shaly  
parting holds trilobites  
heads and fragments.



Thin micaceous sand occurs  
to the summit <sup>the Montezuma</sup> the lower  
band ~~of~~ is essentially a  
repetition of the upper in  
lithological character &  
the same Trilobites heads  
was observed in each.  
The coralline matting is  
seen in the lower half,  
chiefly, also seen to the  
summit.

This band is a portion  
of the Lento group and  
carries the Pennsylvanian  
up to the sandstone.

It is broken up into small  
bands by shaly partings,  
usually arenaceous, and  
again subdivided into  
massive strata and shelled  
strata.

Upper bed	85.	
Center " "	295	
Lower " "	70	450

3 Greenish micaceous shale  
arenaceous shale and a  
few layers of gray sand-  
stone, passing up into  
arenaceous limestone layers  
of preceding 100.

Add section 1 1/2 miles up the  
Colorado. See pg. 74.

Found Trilobitic remains  
Lingula and Hyolithes  
in 3 also in base of (2.)

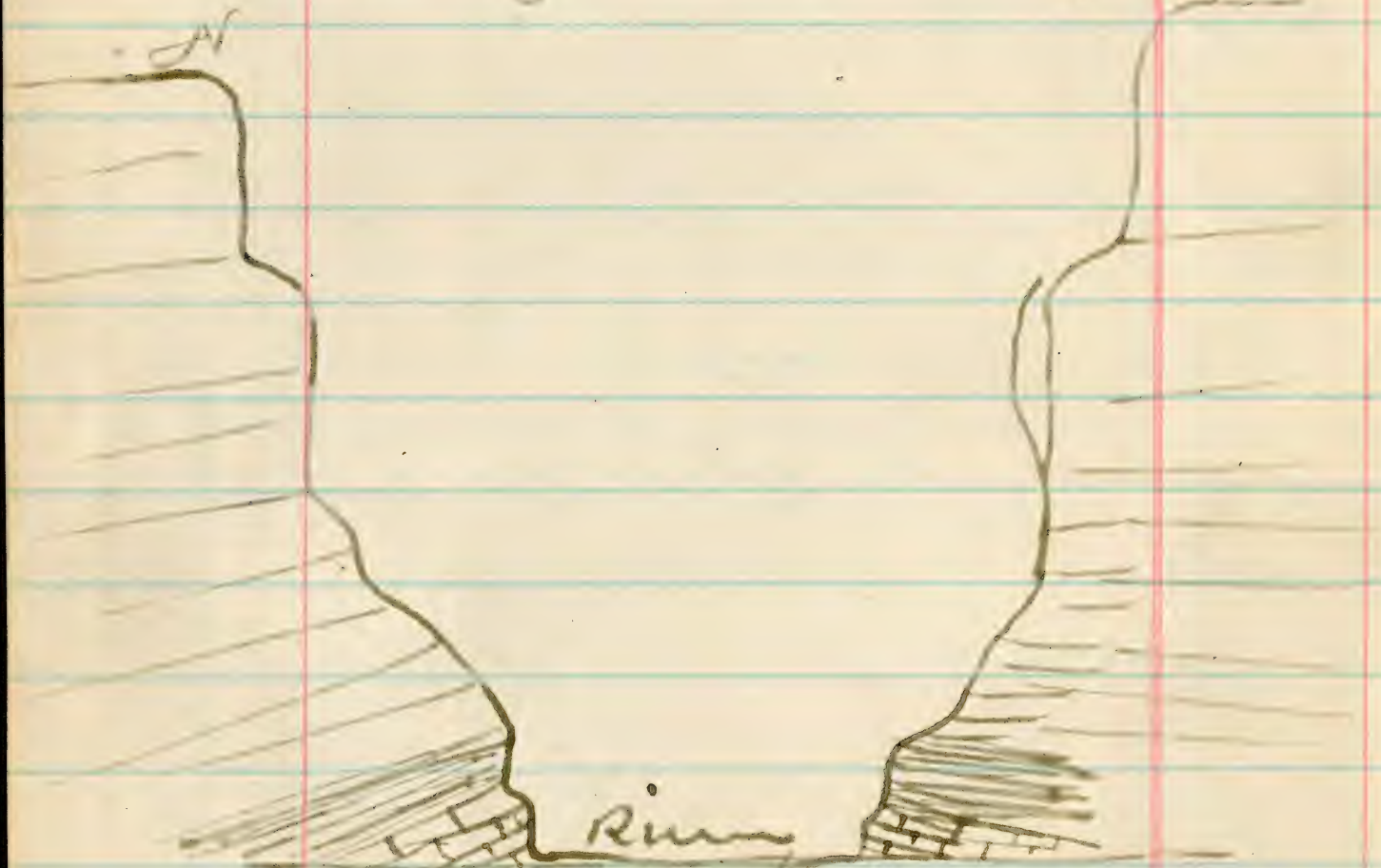
Strata at mouth of Canon. Top of  
lower division of limestone (C)  
at 1.50 & down the Colorado  
to 20.

The calcareous  
the hard sandstone at  
the base of the Lento group  
rises to the A.C. going up the  
river above the mouth of the  
great Canon. About 1/2 mile  
above it is 50 feet above



the water and <sup>just below</sup> at the mouth  
of the Kanab Canon it passes  
beneath the water line.

A half mile above the strata  
on the north side dips 15° to  
the N.W. & on the south  
side of the river 12° to 15° to  
the S.E. The higher strata  
(limestones) do not appear to  
partake of this strong dip



Geocal pushing out of  
strata at base of Canon  
walls

Partial section taken on the east  
side of the canon about 5 miles  
from the Colorado. Oct 27"

1. Gray (light) limestone, resting  
beneath banded cherty lime-  
stone. A cone full search  
did not show any fossil  
remains that could be  
identified as such. 85

2. Sandstone, friable, stained  
purple, with a few lime-  
stone layers in the central  
portion 35

3. This band of sandstone  
forms a shelf which  
extends all along the  
cliffs on each side of the  
Canon & also the Colorado  
Canon above it since  
the archer cliff.

3. Gray limestone, resting  
as 1. 90



4. ~~Impure limestone, anemaceous~~  
in places, with masses of  
caliche. Gray mottled  
with purple. ~~Uniform gray~~  
on weather surfaces.

90 feet from the summit  
the gray limestone again  
predominates and contains  
down 90 feet + becomes  
more anemaceous than  
preceding 25 feet. 185

5. Gray and  
~~Impure limestone passing~~  
into buff sandstone with  
few ~~thin limestone layers~~ 52

Below limestone (2)  
pg 75.

The mottled limestone  
occurs near the base of &  
the purple mottling is weather-  
ing out in relief.

the massive bed  
of ~~limestone~~ with intercalated  
shale layers and collected  
fossils from the same. They  
have a subcarboniferous  
aspect.

146

The chert is in layers  
of nodules + irregular con-  
cretions coincident with  
the bedding + forms about 1/4  
of the mass. Fossils occur  
in abundance near the  
central to upper part. Below  
none were seen.

Spina, Anthris, Chonetes, Modiolus  
etc with many species of  
bryozoans occur.

Thickness of bed 145.



These beds beneath the  
massive gray limestone beneath  
the chert are irregular

Oct 31<sup>st</sup> 79.

In coming up the canon  
noticed several illustrations  
of the erosion of the Silurian  
beds & the deposition of Pontian  
etc. In view to the deposition of the  
limestone also local con-  
ditions of the upper Pontian of  
the Silurian strata.

Remained the chert beds  
three miles above using a line  
100 feet + 75 feet by back level.  
= 150 feet. There are not  
as many fossils at this point  
as below & the proportion of  
chert is less than  
at previous section. The  
chert is light colored  
weathering black.

Continued the massive lime-  
stone above the chert bed  
near above the Sanokanab  
Spring, near Arizona.

The upper Pontian 250  
feet was measured by the Locke  
level. The remaining portion  
with the line & a chert dis-  
tances with the level.

1 Shaly <sup>gray</sup> limestone with fine  
chert and intercalated nar-  
row layers 255

2 Massive light gray lime-  
stone with some finely  
bedded cherty layers near  
the summit. also at 200  
feet below a band of cherty  
layers intercalated with  
the limestone. 487.

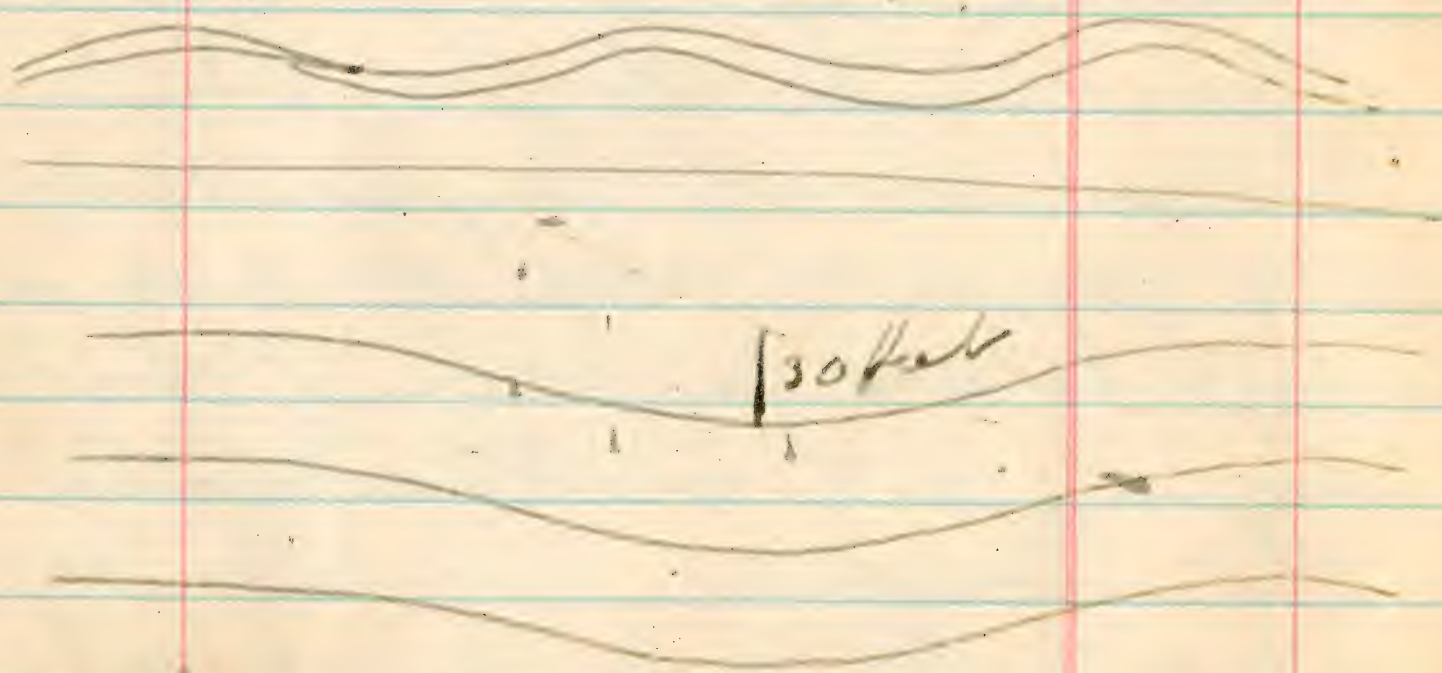
Fossils were found at various  
horizons but none abundantly  
near the summit. A species



of *Syringopora* occurs in great abundance in the form of casts of the stems etc. near the base.

Another section of this bed was taken two miles further up the canon, all but 75 feet (measured by laying a tape by looks level) 477 feet was obtained.

The upper layer of the limestone. (the two upper bands) are very unevenly bedded forming undulations.



This irregularity is taken up by the bed above.

so that at the base of the purple sandstone the even horizon is restored.

The massive light gray limestone is usually divided in ~~four~~ six massive bands which frequently break into several thinner bands. The ~~upper~~ cherty bed is not persistent after being absent & the limestone uniform.

Recess oblique to the stratification occurs in the limestones of the Carboniferous.





Porto's section. Head of Canon  
in same limestone. Lower  
Kanab Canon, Arizona.

Gray limestone with white  
chert passing into shaly  
limestone with pink or  
red chert and then  
becoming more arenaceous  
with thin bands of  
pink chert & shaly lime-  
stone. 300 feet.

The banding both above and  
below of this band is very  
changeable. Below the upper  
surface of the limestone will  
cause variations of from 20 to 50  
feet & above the pink chert  
may run up into the sandstone  
much further in some places  
than others. The purple  
sandstone above was 40  
feet in thickness where

the section was taken.

The first bed is a <sup>bed of</sup> passage  
from the limestone to the  
sandstone.

The highest inclination  
of the laminated layers  
of the crossbedded sand-  
stone that was observed  
is  $27^{\circ}$ . The highest general  
average is about  $20^{\circ}$  to  $23^{\circ}$ .



Local faulting in Co. 2nd  
white band in  
Cliffs.



88

89



146

147



148

149







RU 7004 / Walcott  
Arizona Grand Canyon  
Field Notes 1879  
found between pp 148-9



## Faults.

Pg 4. Fault in the canyon Kanab creek. Pg

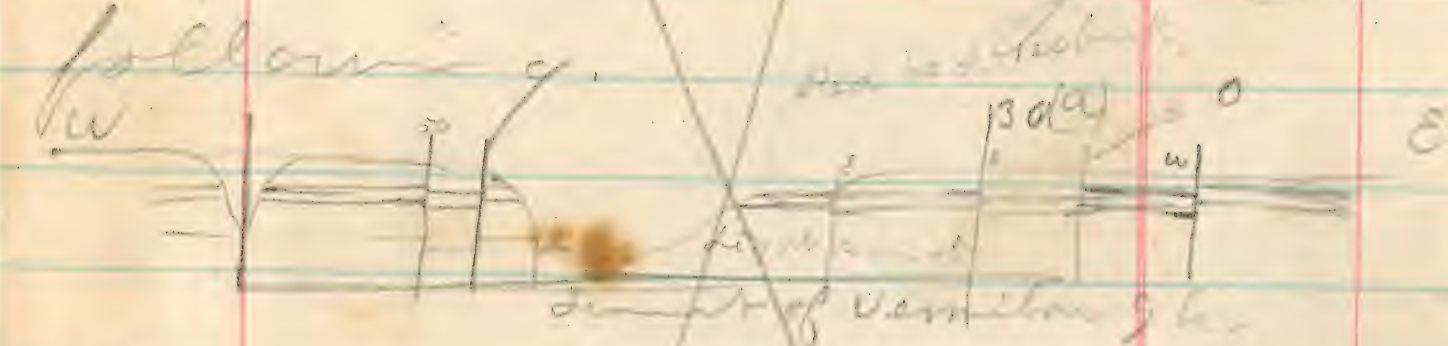
Pg 11. Fault 100' E of Kanab in Vermilion Cliffs.

At the mouth of the Kanab canyon in the Vermilion Cliffs. A fault occurs on the west side crossing the spur that runs out to the south which forms the west side of the canyon just before it widens out to form the amphitheater about the village of Kanab.

Line of fault S.E. x N.W. with a down throw to the S.W. of 65 feet. The calcareous layer rests at the summit of each level. In the N.W. (1/2 mile) the fault appears to be running down through the red shale to lowest gray cross-bedded sandstone with the dip, both west. On the north side

of the spur there is a cliff crossing S.W. + N.E. + there a deep occurs to the north of 100 feet.

Crossing the Kanab Canyon 3 miles above Kanab there are two ravines, one on the E & W side. A cross section of the canyon top the ravines gives the following.



The general impression gained at this point is that there was a slight fold with a general drop to the west (but slight). In the vicinity of (a) West side there were a number of cracks running right from the summit of the hills down to the base. The displacement was too slight (or too small) to be noticeable at a distance.

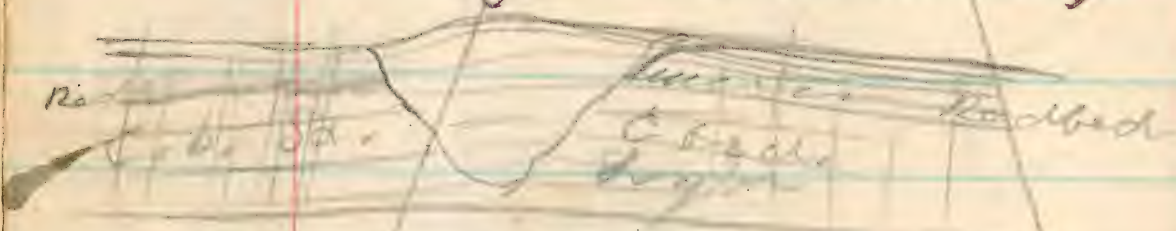


a section from the N.E. side of the ravine as seen from 2 1/2 up the hillside that the side is elevated nearly 50 feet above the west bank of the red land (which is forested at the same height for many miles)

(Rexamine)

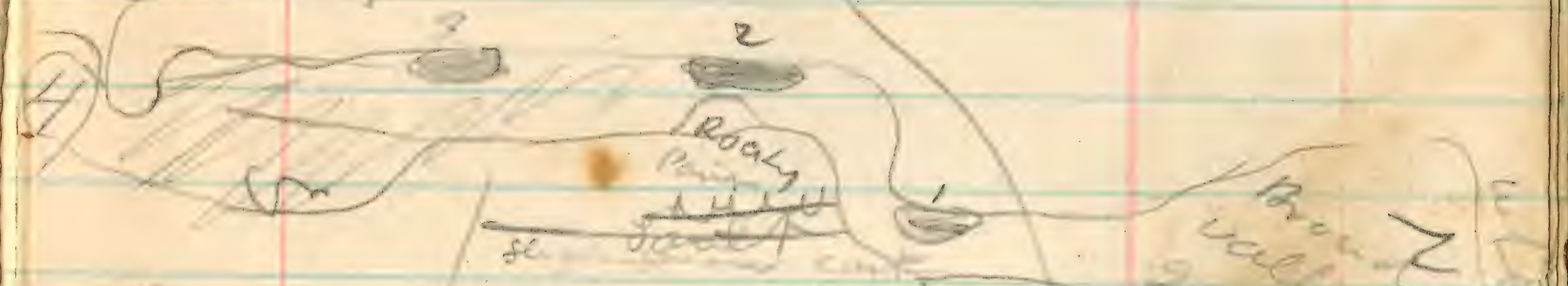


(Rexamine)



The ravine up which the road to Long valley passes branches to the west & then turns north. A fault occurs at a short distance from

the canon with a N.W. & S.E. line, with a drop of 50 feet to the higher of the ravine divides. The West branch carrying the road to the North passes on apparently along the line of a slight fault. High up there small lakes occur.



The only agent that has left the cut above is ice. The lakes are small. No (2) occurs just before an abrupt turn in the canon. No (2) lies against a small fault & is partially cut off by a low rocky point crossing the canon. No (3) shows the expansion of the canon & the appearance of the bottom another small



1524

happet day below the  
next turn of the ravine (?)

1525

On the summit of the lift  
2<sup>m</sup> S.W. of Pile's old place  
Kanal (Upper) valley 8800 feet  
there is a cap of basaltic lava  
300 feet thick. On the west  
the top of the Pink Cliff limestone  
barrier division is on the same  
level as the top of the lava.  
The strata dip North  $2\frac{1}{2}^{\circ}$  which  
cut apparent E + W dip. It is on  
the west side of the fault running  
from the Pink Cliff uplift west of the  
divide at the North end of the  
upper Kanal valley. On the  
east the Cretaceous strata  
of the ~~Barren~~ coal division  
cross from the eastern fault  
over Pink + Kanal valleys  
up to the large canon that  
leads up to the lava bed.  
The strata preserve uniform  
dip slightly rising to the west  
& south until it passes beneath  
the lava. There is no



8825  
8575  
250

1-621

evidence of a monoclinical fold. To the north the tertiary strata rise from the N.W. No evidence of its presence was seen on the lava capped hill.

On the next Knoll south of the buff sandstone outcrop with a dip of  $100^{\circ}$  N.W. 8825. No means of determining the position of the sandstone existed beyond the probability that it belonged to the upper division of the Cretaceous. There must be a fault east between this point & the Kanab valley lower position.

a little south and 250 feet lower the Astrea bed occurs in position dipping N.W.  $100^{\circ}$ .

Dip  $75^{\circ}$  x 250 ft 320 feet

157

Astrea bed beneath sandstone on top of hill. This is a continuation of the dip & strata measured  $1\frac{1}{2}$  mi N. above the Lenticular bed dipping  $10^{\circ}$  N.W.

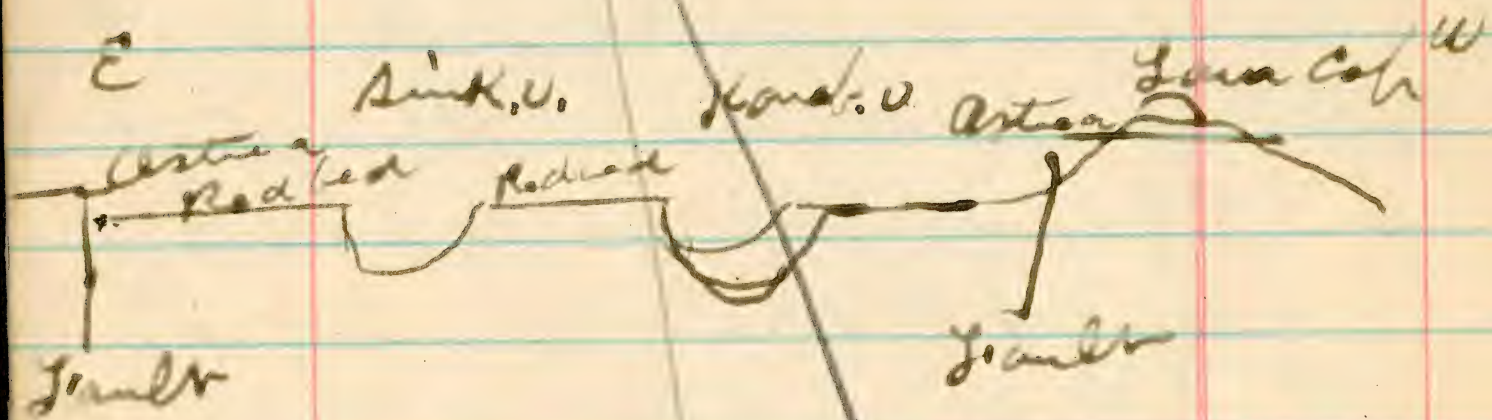
The Astrea bed again occurs to the S.W. at a level of 75<sup>8900</sup> feet below the other outcrop & dipping N.W. exact dip could not be determined.

Also occurs again west of N.W. slope at 8450 sloping S.E. & again <sup>8350</sup> on high hill N of Upper Volcano in valley below Silver. The dip here is  $30^{\circ}$  N.W. The rock is filled with the Astrea shells.

Quantities of large fragments of the Astrea bed and the sandstone underlying it occur at different levels. In 300 feet below on the



hill side towards the Cretaceous.



The Cretaceous strata dip to the N.E., rising to the S.W. The base of the coal series above the gyphifera monls is 7650.

Thickness to Astrea bed, 1230.  
8880

Lower Astrea bed 8350  
530.

530 = fault a lowest estimate, but as the Astrea bed + associated strata dip N.W. 100 + there have Cretaceous strata there is evidently an uplift towards the volcano the south of the strata west of the fault. From the Astrea bed occurring at

different levels in the E + W line there are several parallel faults across the west side of the valley to the north towards the Pink Cliff uplift. The strata on the other side of the long valley canon are separated by a still greater downthrow to the west, or rather I would regard the Cretaceous strata as having been elevated.

The lava flow occurring on top of the hill points to the source of the disturbance especially as the fault line is on a line with the volcano below.

The fault or faults crossing over from the Devian pass on the west side of the long valley above white cliff & apparent white to go south thro' the long valley canon.



The eastern end of the Canyon is the divide separating the Cretaceous of the valley from the Tertiary and Cretaceous N.W. uplifts in the western hills over to the Long Valley canon. No evidence of a fault was observed in the Kanab Canon white cliffs or in the canon east to the 2d opening in the Johnson canon. To the west no observations were taken in the White Cliffs as the Long Valley canon cuts off faults in that direction.

Note. From the base of the gray sandstone (sometimes conglomerate) beneath the Pink Cliff limestone to the arenaceous clays, beneath the massive sandstone next below the red bed appear to be a great natural growth characterized by the presence of sandstones + clays fragmenting in great numbers as compared with the red.

<sup>2</sup> The next division consists of clays + muds arenaceous soft & easily disintegrating shales extend down to the red bed or shale above the sandstones containing many fossils. This division forming low rounded hills usually extending southward to the next bench of browned red.



162.

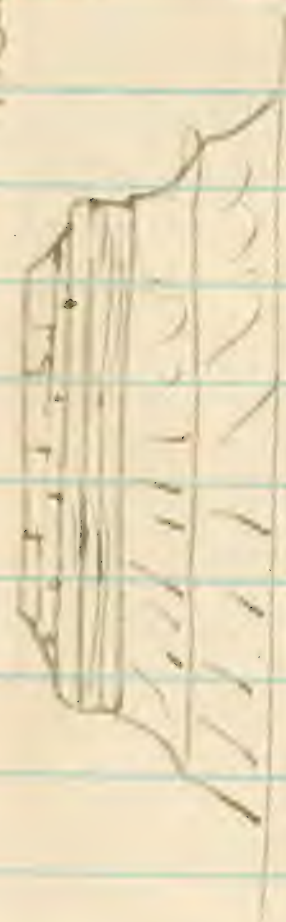
3. The ~~gast~~ sandstone beneath gradually giving way to bands of shale & bituminous clays with coal extending down to gypsiferous layers above massive

4. The gypsiferous clays & conglomerate peaking to the massive limestone

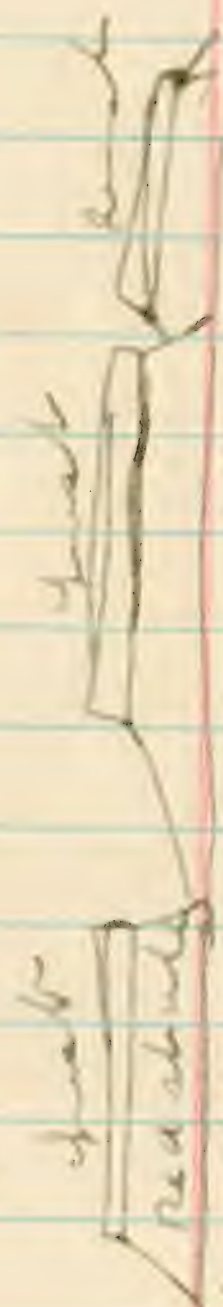
massive to white cliff sandstone.



Rubble source of glauconite



163.



Rubble south of limestone cliff.  
12 mi S.S.W. of Kansas  
unconformity with the rubble beneath. coarse sand above the  
bottom of the rubble.



1640

Entrance strata west of the  
limestone uplift west side of  
Kane Valley (uphill)

- |                            |       |
|----------------------------|-------|
| Cream colored limestone    | 50 ft |
| 1 White band               | 25 "  |
| 2 Pink (dark)              | 100 " |
| 3 Cream colored sd.        | 50 "  |
| 4 Cream colored limestone  | 100 " |
| 5 Pink (reddish) limestone | 150 " |

6 succeeding well south  
uplifted with buff sd,  
such as occurs beneath  
the Pink Cliffs & strong  
iron stained sand  
occurs about 200 feet  
down. 300-

7 Just to the S.W. of this hill  
there is a hill of white  
massive limestone  
similar to the limestone  
above the redish band

165 166 167

A small shell was observed  
from the sandstone. No  
fossils yet observed in  
the limestone. —  
white limestone.

Rd dips more to the N.  
white limestone S.W. 300 feet  
— common. The hill is  
with a few small fossils.  
limestone. —  
to the S.W. is a small  
a higher angle 30° to 40° S. W.  
dip as far as examined.  
owing to the complexity  
of the structure of the  
limestone etc. & the fact that  
it is very rare to find  
good outcrops I gave  
up trying to find fossils  
in the limestone. It is  
very difficult to find  
fossils in the limestone.



Upper Kanab. Head of Valley.  
 The Pink Cliff run N + S as  
 on map, the cretaceous  
 running in nearly a parallel  
 line for along distance  
 just west N + S of the  
 divide. Coming into pink  
 valley on the South. The  
 cretaceous is 1 mile or more  
 in width across the divide  
 is replaced by the redish  
 conglomerate which in  
 turn gives way to the  
 Pink Cliff uplift to the west  
 of the trail over the divide.

The cretaceous rock con-  
 sists south of the cong-  
 lomerate & Pink Cliff uplift

N of the divide. West of  
 the trail the beds are  
 the same apparently as  
 west of Kanab valley.  
 (after) It may be seen

extension of north for miles  
 in the Kanab Valley.  
 Rocks South + W of uplift  
 (P.C.) have not yet examined  
 Sep. 8. 1879.

South of the Pink Cliff uplift  
 the sandstones beneath rise at  
 an angle of  $28^{\circ}$  for a mile  
 the dip is N. W.

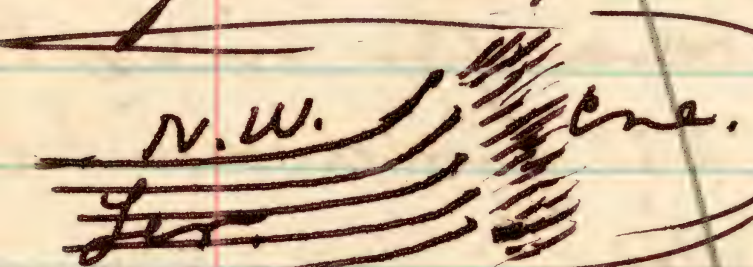
Elevation of Pink Cliff  
 uplift 8925 feet. Strata beneath  
 retain the same dip  $28^{\circ}$  N. W.  
 and pass down through  
 the Lenticular bed beneath  
 the Pink Cliffs to the upper  
 portion of the Cretaceous.

The distance to the lower  
 outcrop in the valley to the  
 S is  $1\frac{1}{2}$  miles. Elevation

On the west side of this  
 uplift Lenticular limestone  
 may be seen meeting against  
 the sandstone, inclined

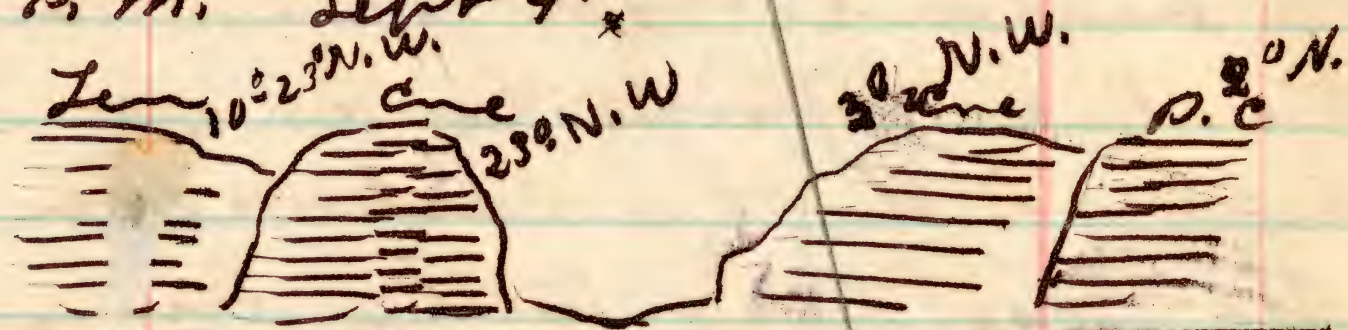


at the point 17 of contact at  
the same angle but a  
short distance back it is  
reduced to  $10^{\circ}$  <sup>W. 25° N.W.</sup> & soon  
assumes the horizontal  
position E. & W. with a  
slight dip to the north.

 Whether a  
fault exists  
to the west was  
not determined at date of  
uniting Sept 9<sup>th</sup> 1879.

Elevation of Lantry hill, west  
of Anetaceous uplift ~~8500~~ <sup>8500</sup>.

P. S. M. Sept 9<sup>th</sup>



E + W section south of P. C.  
Uplift.  $1\frac{1}{2}$  miles.

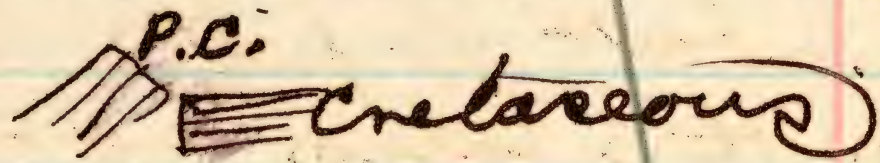
17.1. A fault or synclinal  
is shown by sketches 1 + 2.  
10<sup>th</sup> miles west of Lantry  
hills. The strata of the  
Lantry ridge dip  $25^{\circ}$  N.W.  
& the strata on the hills  
west 1 mile dip  $5^{\circ}$  N.E.  
The hills west are composed  
of limestone capped with  
sandstone. A section in  
some of the hills is  
bluffs to the east. The  
fault passes down the  
valley west of the ridge &  
appears to be the  
westernmost low down  
containing the highest  
ridge from the valley  
side.



Upper Kanab valley, West side  
8250. B. at 2.0 P.M. Sept 8. 79.

The Pink Cliffs facing W & S.W show a slight dip to the N about 20°. The Cretaceous strata to the west have the same dip & the Astoria bed 16.00 feet from the summit of the series of Cretaceous beds is a marked feature of the landscape, rising as it does 88050 feet above tide with the high Pink Cliff back feet above tide.

On the left the beds of the Pink Cliff of the west side of the valley dip N. at an angle of 28° rising against the Cretaceous rocks



*[Faint, mostly illegible handwritten notes at the bottom of page 172.]*

To the west the strata have the uniform dip to the north and consist of higher beds (apparently still cannot tell). Color is white, capped with redish brown. The Glendale fault may lift the Pink Cliff or depress the white beds. The redish beds are capped with white limestone 4 miles west of Kanab valley (Upper). The summit of the Pink Cliff uplift on the west side is 8925. 2.30 P.M. Sept 8. 79. A little west of the road over the divide leading down to Kanab valley there is a mass of redish colored conglomerate, about 75 feet is exposed above the talus. It is the matrix is a redish hard fine sand or marginalaceous material & has embedded



in it fragments of pink  
limestone & sandstone brecciated  
also small pebbles of quartz.  
The pink rock prevailing.  
The bed would appear to  
be made from the destruc-  
tion of the pink cliffs  
limestones & sd.

Barometer 8800. 4.0 P.M.  
Sept. 8. " 1879. Dip 52 N.

Cretaceous hill E of last  
9100. 4.30 P.M.

See sketch of valley &  
divide from this point.

Strata of redish conglomerate  
& pebbles of same extent  
175 feet higher up the  
hill than the summit  
given above viz. 8800.

Altitude 8275 on line  
of Sect south of Can 9.  
Sept 8. 1879.

Ripple marks & other evidence  
of littoral foundation in the  
limestone.

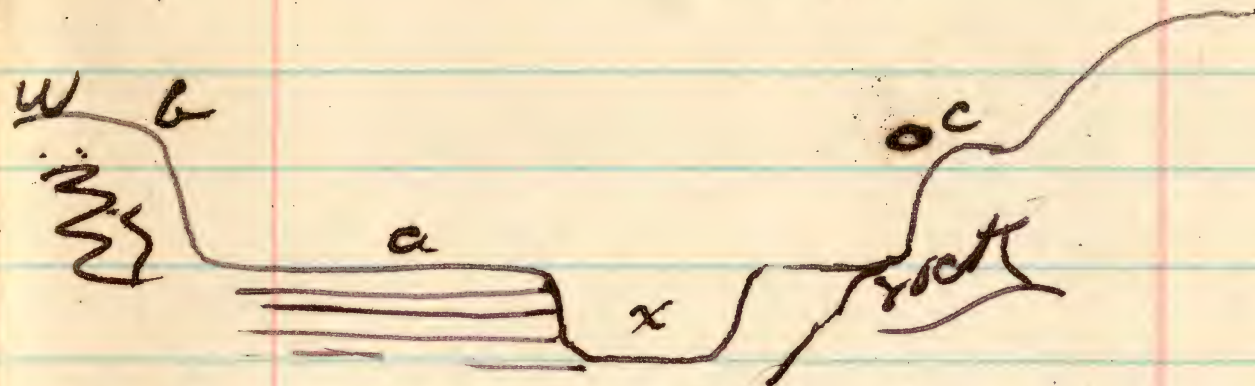
Ripple marked slabs were seen at  
various horizons in the Shinarump  
gp. Vermilion & white cliffs.  
Mud cracks also occur throughout  
the ~~same~~ argillaceous shales.

The numerous beds of crossbedded  
sandstone & siltstone indicate rapid  
currents & "distributing" of sediments  
in the water such a strong  
rapid flow would produce  
such a "mud bank".

& the bottom of the  
cliff face. The light colored  
sandstone is literally perforated  
in all directions by the roots  
of worm borings. The yellowish  
filling weather out of place  
many feet the rock is  
hardly pitted. The rock is very  
irregular & crumbly  
the local of the sand.



The sandstones of the lower portion of the Crasebedded ss of the W. C. Gp., are usually very fossil when exposed to the weather at an angle to the outcrop. The general appearance of the beds is such that it appears that the thin layers were laid down by a gentle current, such as the daily tidal current and then heavily strong currents tidal or storm level off the surface and formed a smooth floor upon which it deposited a layer of sand which then was again buried beneath the shifting sands which in turn were level off again etc., etc.



\* Present bed of springs + stream of Kanab creek. Vermilion cliff a deposit of sand etc., evenly bedded + showing source of material in the red + light colored layers caused by the wash from the red and white beds above. Height of terrace 35. (b) A second terrace of sand extending to the west of (c) the red sandrock has a grayish color probably owing to the upper terrace having rested against it. The lower terrace can be traced down the cañon for two miles or more evidence of the upper terrace (b) is seen but a short distance.



+

176

From the summit of the white cliff on the west side of the Kanab canon looking east it appears that the white cliff (summit) is elevated 600 or 700 feet above the western edge of the same canon. This must be owing to the fault which crosses from the upper Kanab Canon S.E. to the Johnson Canon on E. of Clarkston. The white cliff also has a slight dip S.E. from the Kanab Canon. An extension of the long valley fault to the Johnson canon.

No evidence of a fault was obtained at the mouth of the Kanab canon in the white cliff.

The lava flowing from the Volcano at the head of the canon in the white cliff

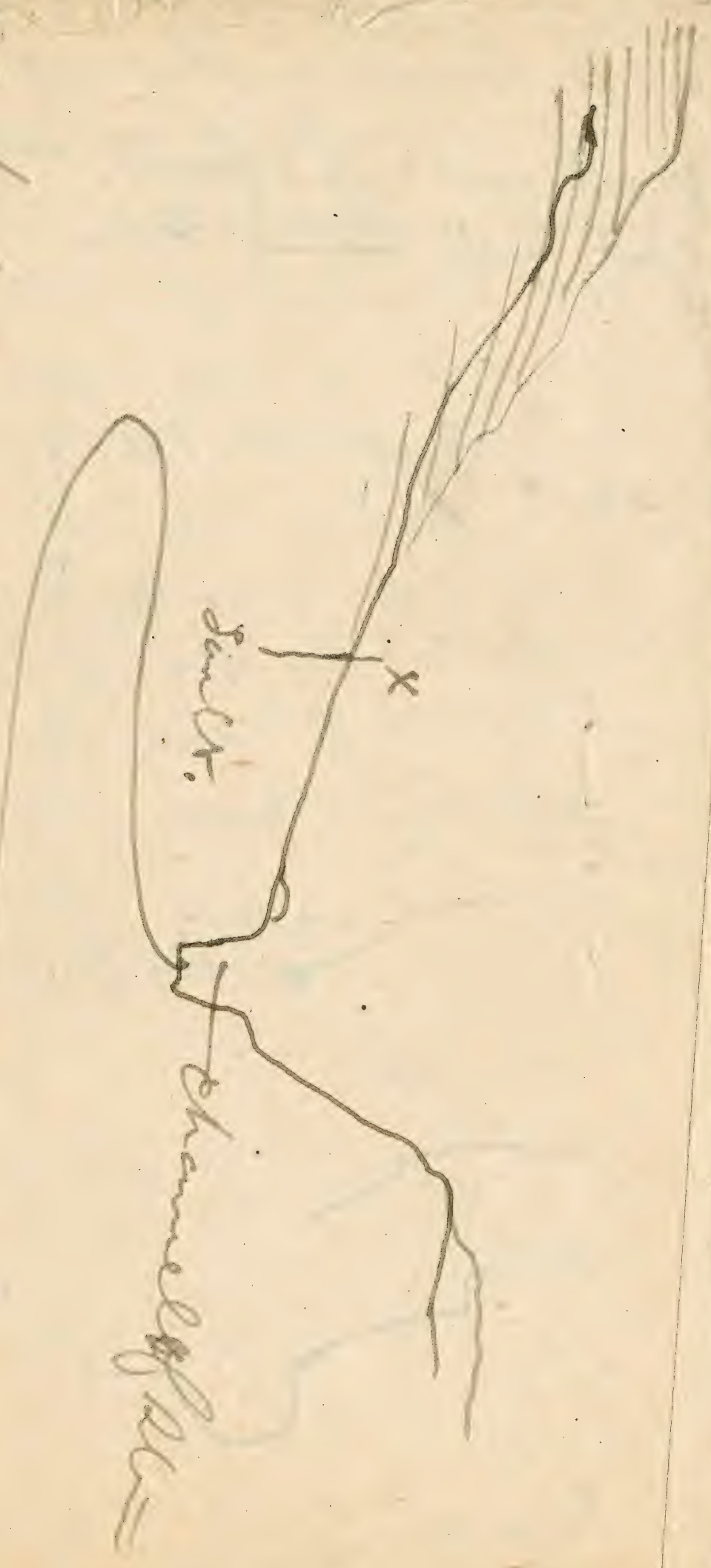
177

passes down the old canon of the Kanab valley entering the present broad canon & flowing for a long distance on the east side. Since the lava flow the canon has been worn much larger on the west side & the lava stands on black wall on the eastern side covering finally like a great snake down the canon following the old anastomosing channel of the stream thro' the canon. At the head of the lava stream the volcano decided the old valley into two water sheds one passing down thro' the old drainage line on the west cutting thro' the lava bed to enter the main canon. The other, we may call a new channel down which the present water runs.



Lower left North

(1) Antelope



a fault occurs at X. It may be seen also  
the same

does not show as well as appears. Has nothing to do with

white cliffs

178

some of which will be found





base of hills North

(1) anticline near

river valley

40 N.

(2)

Aug 5<sup>th</sup> 77

3d Camp

N

S

179

pink & grey  
spills 90

fault

basaltic rock

pink beds 25 2120 S

(a)

Red A. 2

Seen from 2 mile to the south of (1)  
the redish beds at (a) next when & a granite the wooded  
pink beds the pink beds have beneath lower beds to.  
the north. South the hills are wooded & the redish  
does not show as well. Aug 5<sup>th</sup> 77. See notes of Nov 1910

white cliffs

178

Summit of mountain with wood around





Opposite Hillsdale the  
P. C. strata dip 40 west  
on the north side of  
the E & W canon.

See page 179 of note  
book.



1. Dark pink & resting on eroded  
surface of 2.

2. Pink cliff quar dip 30 N.E.

3. " " " " 20 W-40 N. to  
base beneath lower beds.

Taken 6 miles south of Hillsdale  
from W side of main river.

Nov 14" 79.



Lava

P.C.

P.C. 20.20

Washed

P.C. (10.00)

P.C.

For Butlin's Ranch.

10.11

0

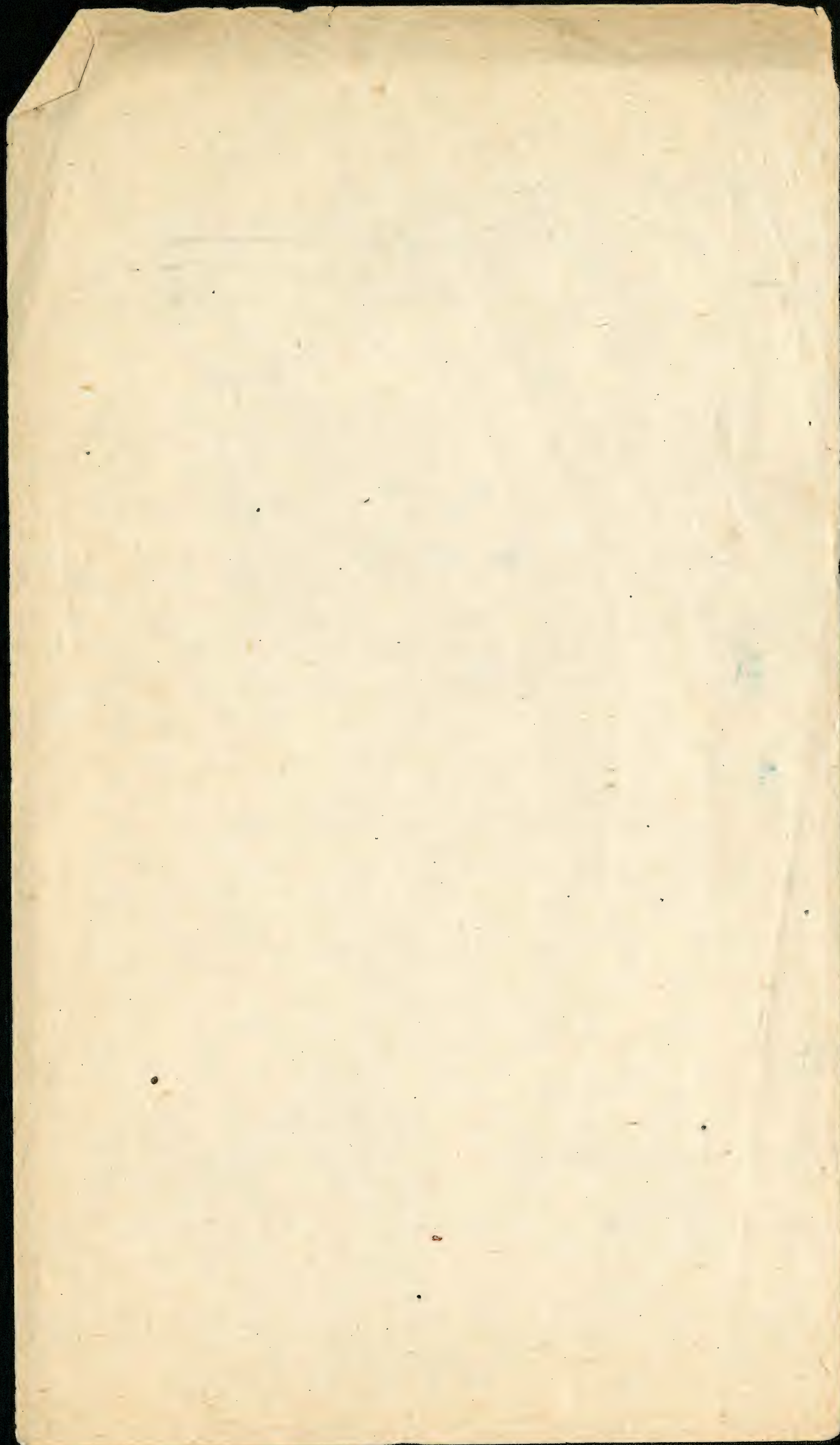


Summit of Cherty Lush  
Krab Canyon. Utah. Oct 6<sup>th</sup> 29  
(1)

Viewed from the summit  
of the cliff west side  
300 feet above the canyon  
bed. The strata of the  
upper 150 feet are seen  
to be mainly bedded  
and also curved more  
or less in beds not in  
relation to any definite  
direction but as tho' the  
bed upon which they  
were deposited was uneven.  
are dipping south.





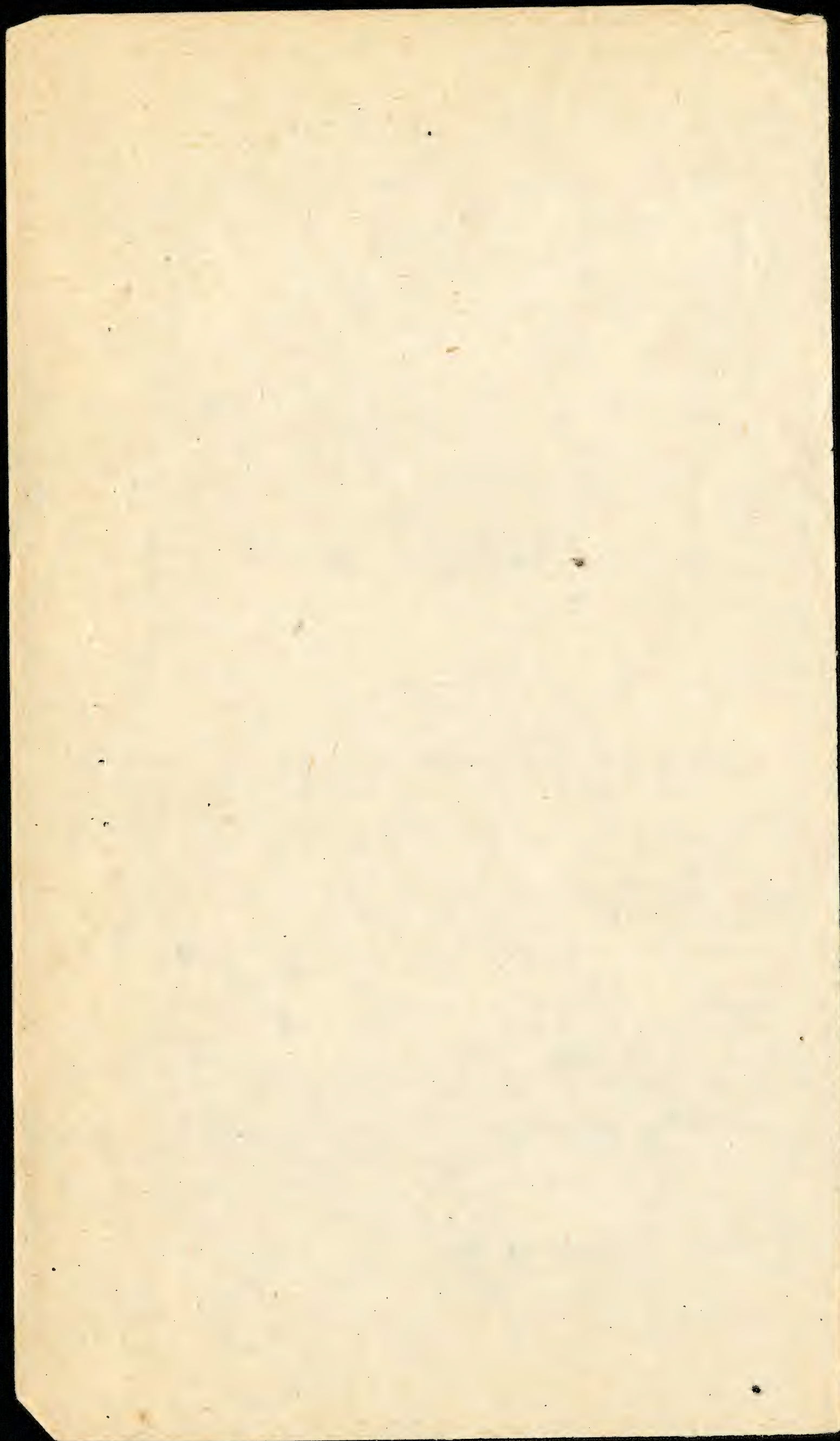




When the red bed makes  
its appearance above and  
below the left hand or  
east canon going down  
the fault is very plainly  
seen. The dam then is to  
the west and is over 100  
feet. The strata bend towards  
the from the east and rise  
towards the west slightly.









Point X  
Channel of the



a part or corner of X. It may be seen also  
the river

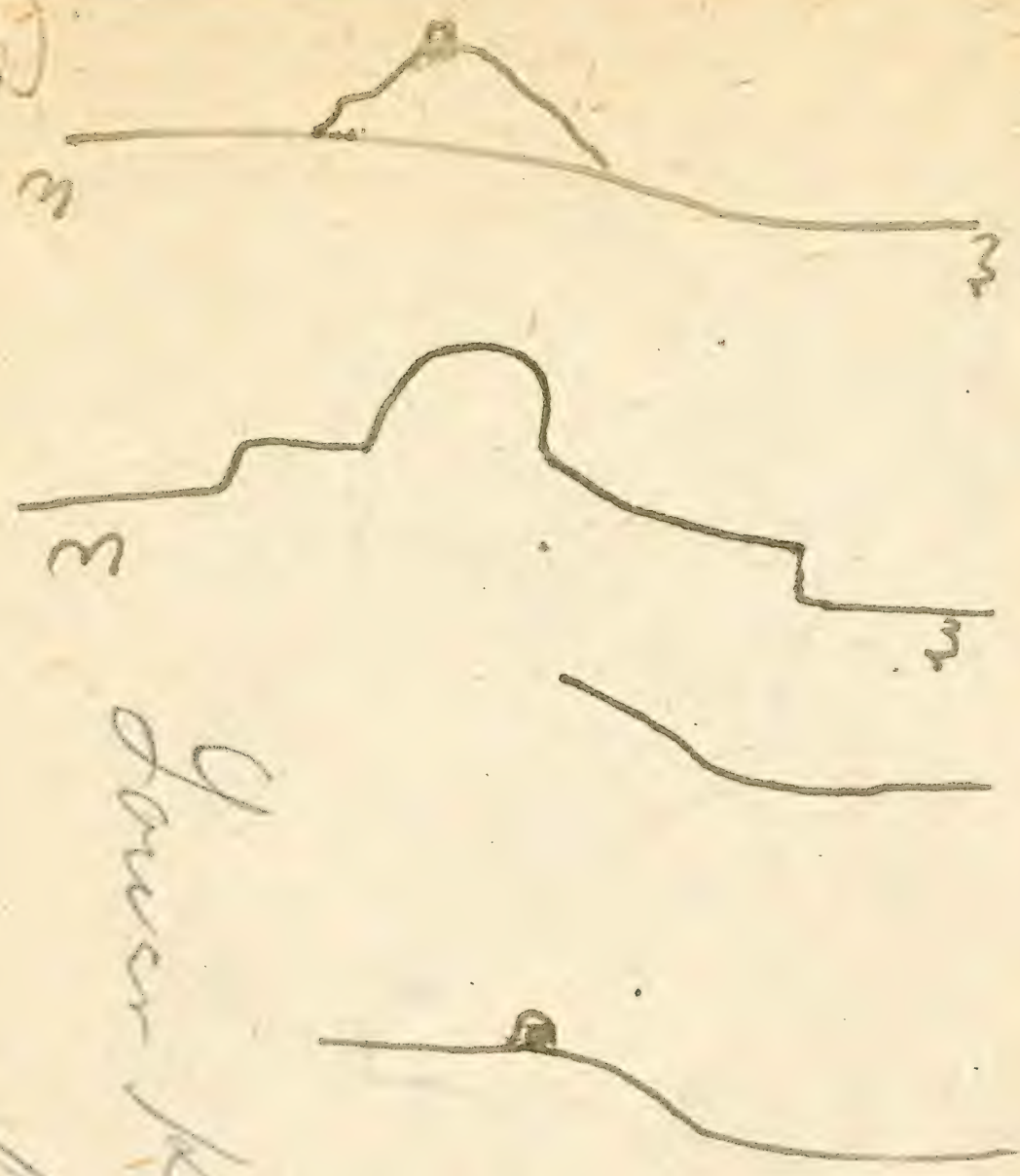


Section across canyon at  
 upper alkaline spring  
 West side, Redford Red 5925.  
 East side same beds.  
 5750  
 175

Oct 11, 1917

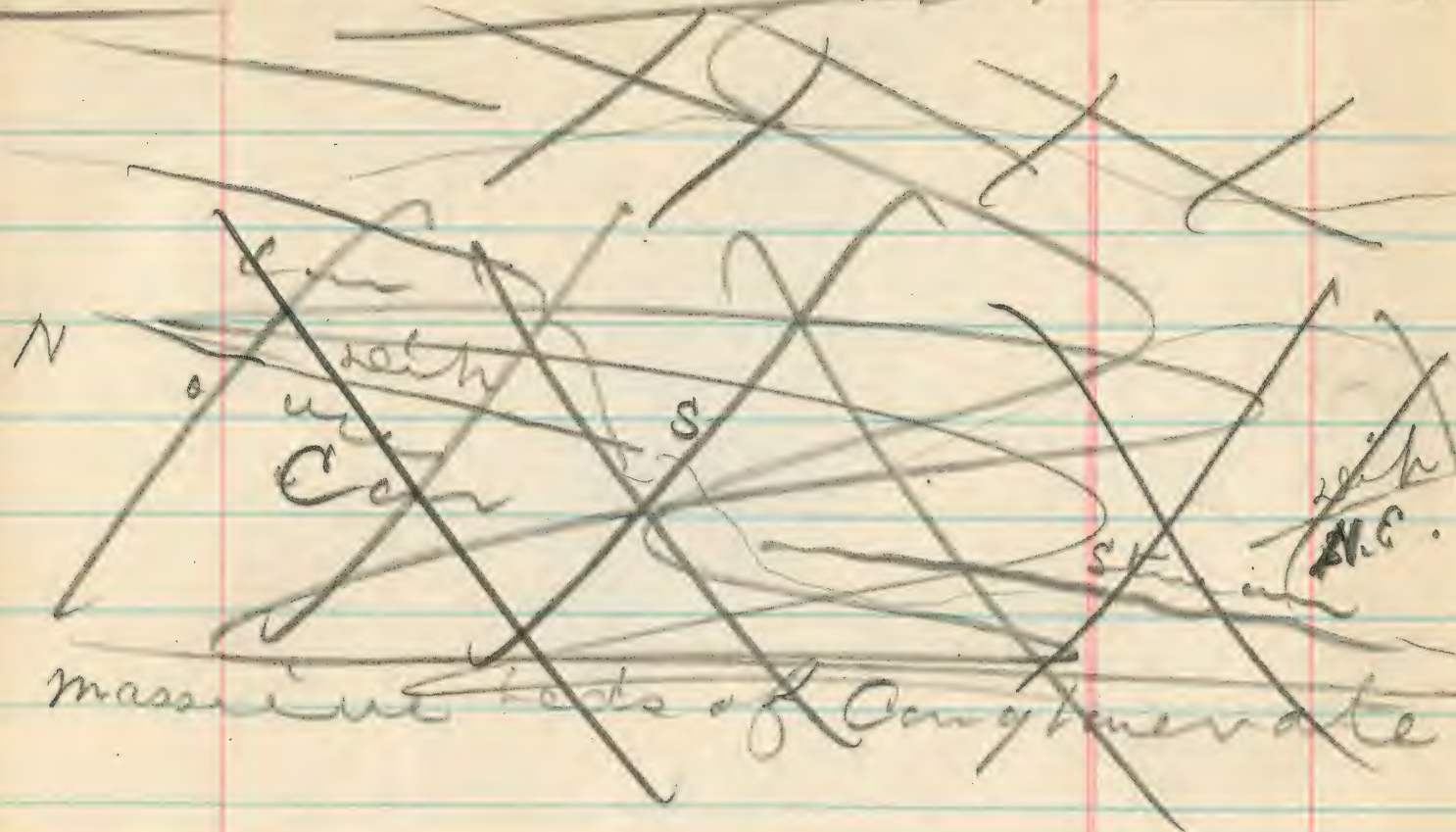
Grover Beach Canon

fault





~~Tremonts Pass Aug 7<sup>th</sup> 79~~



stream

1st Camp



Tremonts pass. Aug 6/79

South side, 5 miles up pass from  
the west entrance.

Base of section light colored  
thick bedded sandstone (2)  
with layers of bedded (?)  
conglomerate intercalated,  
about 60 feet.

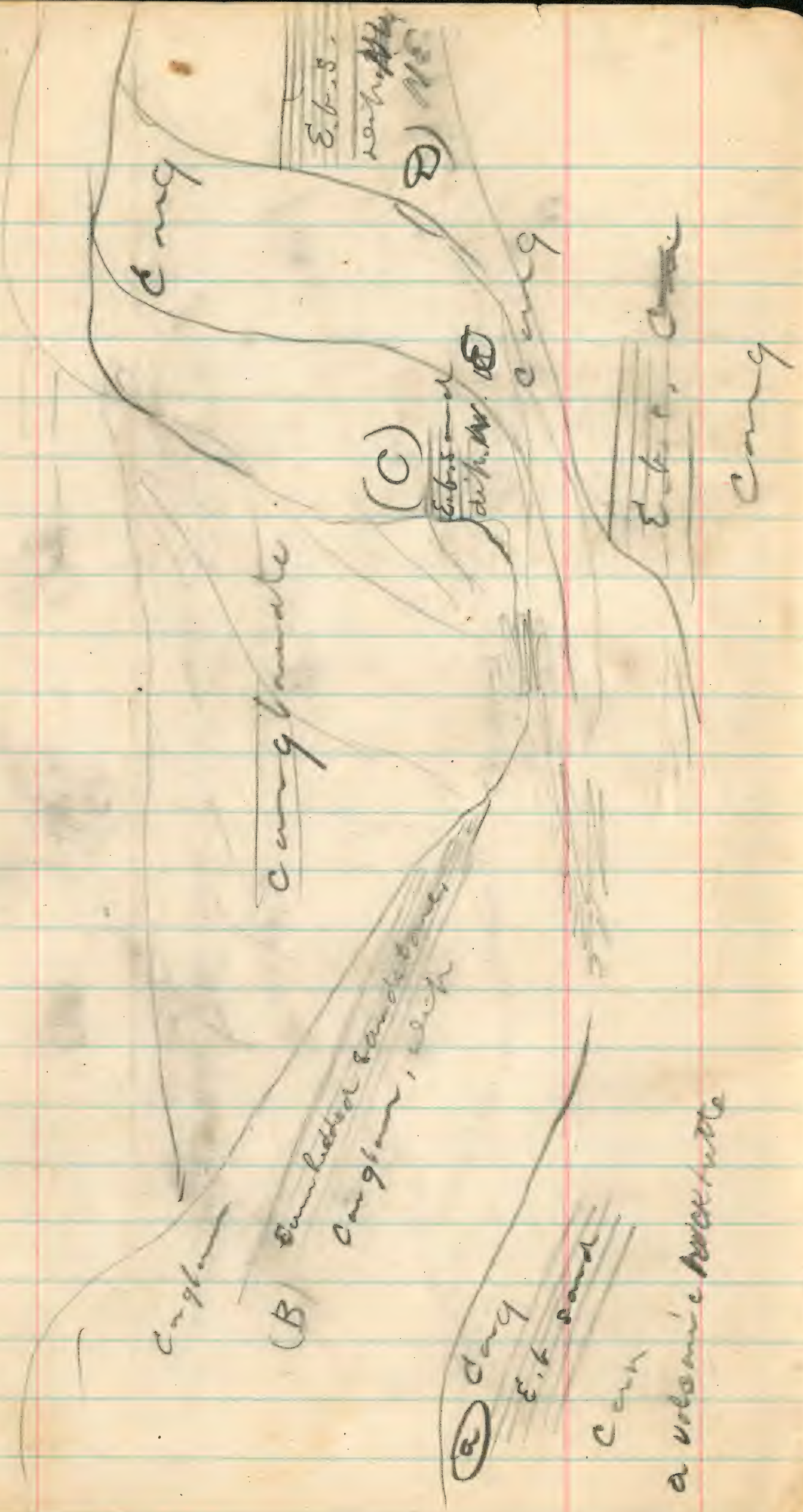
The conglomerate is composed  
of <sup>small</sup> broken, angular fragments  
of volcanic rock and larger  
rounded stones & some boulders  
of from 2 to 3 feet in diameter.

The sandstone matrix is of  
medium hardness & when  
the broken stone are removed  
gives the appearance of  
a bed of ~~massive~~ subblestone  
work.

Near the summit the  
sandstone is more of a yellow-  
ish color & is immediately  
overlain by a thick deposit  
of volcanic rock (1) 30  
feet thick. This is evidently

an intercalated bed.)  
The entire <sup>sandstone</sup> conglomerate  
has the appearance of  
having been deposited  
rapidly. The sandstone  
being deposited and  
mingled with the products  
of volcanic eruptions.  
& the broken & rounded  
fragments of beds of lava  
etc. Dip of <sup>bedded</sup> sandstone about  
15° N. Above the ~~same~~  
bedded sandstone layers there  
is 4 or 500 feet of coarse ~~conglomerate~~  
this may be seen extending  
down the pass for several  
miles, if the dip is retained  
& the strike. A view from  
the opposite hill (West)  
gives the following  
section.







at Pahranaagat, Lincoln Co. Nevada  
Dr Newberry stated that ~~thousands~~  
well preserved silurian fossils occur.  
Primordial. South of Ogden and  
also 50 miles south of Fish Spring.

Wahsatch range + Sierra Nevada elevated  
at the close of the Jurassio. <sup>Whelan pg 27.</sup> &  
slight changes as late as theocene  
Tertiary

Whelan Rept.  
sect III = upper half of Karab section.  
" IV = " "  
" VI = Lower " "

Sect pg 270 = Karab sect?.

Received from Mr Bodfish  
1. Clinometer.  
1. Lock's level.  
1. Tape line - 50 feet.



51  
 19  
 376  
 23 13 38  
 158 32  
 105 14 90  
 120 85 91  
 12 132  
 321  
 Sink valley 28  
 140  
 Road to Mr. Silvers 161  
 24  
 185  
 50  
 40  
 235

6000  
 5775  
 225  
 13  
 5  
 65  
 13  
 5  
 65

Aug 19<sup>th</sup> Barometer station  
 5525 feet 8 A.M. 4 P.M. on summit  
 6275 top of hill 6325  
 5525 250  
 35  
 85  
 45  
 41.5

Aug 23<sup>rd</sup> and at summit of  
 white capped ridge  
 of Aug 19 - 2505 - 5775 10 A.M. 1  
 at point of Van Allen 5955 - 10:30 - 2  
 " " of red shale 6450 - 11:30 - 3  
 top of hill  
 at 1. 2 P.M. 5840 2 P.M. 1

Massin was lost 241x  
 Chink bed 150x

Record of specimens  
Vermilion Cliffs.

Conglomerate.

180  
 345  
 510  
 35  
 90  
 6  
 30  
 64.5 13  
 53 73  
 23  
 19  
 95  
 105

320  
 12  
 60  
 9  
 66  
 26

Annularia (Shinarump).

To fish bed from top - 250  
 Fish beds & shonings 100  
 To top of Shinarump 210  
 Shinarump marls 540  
 etc 350  
 Estimate to top of conglomerate 350

8925  
 85  
 375

8800  
 7650  
 1150

5525  
 507  
 28

150  
 320  
 120  
 1150  
 2055

101  
 22



51  
 19  
 38  
 23 13 38  
 158 32  
 105 14 9  
 120 88 9  
 132  
 321  
 Sink valley 28  
 140  
 Road to Mr. Gule's 161  
 24  
 185  
 50  
 40  
 235  
 6000  
 5775  
 225  
 13  
 5  
 65

Aneroid.  
 Base of creek bed 5925

Aug 19<sup>th</sup>. Base at Baromet. station.  
 5325 feet. 8 A.M. 4 P.M. on Summit  
 6275 top of Hill 6325  
 5525  
 7500  
 250  
 35  
 85  
 45  
 415

Aug 23<sup>rd</sup>. And at summit of  
 white capped ridge 100  
 of Aug 19 - 2505 - 5775 - 10 A.M. 1  
 at summit of Van Allen 5985 - 10.30 - 2  
 " " of red shale 6450 - 11.30 - 3  
 top of hill  
 at 11 2 P.M. 5840 2 P.M. 1

Massin sea level 241\*  
 Chert bed 150\*

Record of specimens  
 Vermilion Cliffs.  
 540  
 150  
 220  
 6280  
 30  
 645 13  
 527 73  
 23  
 180  
 340  
 720  
 510  
 35  
 90  
 6  
 8  
 N  
 8925  
 85  
 375  
 5525  
 5275  
 25  
 24  
 11  
 32





